The classroom as context for bullying

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A social network approach

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The classroom as context for bullying

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Chapter 1

Introduction

1.1 The bullying problem

Bullying at school is a complex social problem. It is traditionally referred to as "intentional and harmful behavior which is targeted repeatedly at one and the same individual who finds it difficult to defend him- or herself" (Olweus, 1993). Building on this interpretation of bullying, researchers recently questioned the repetitive nature of bullying, because a single bullying incident can also be very harmful to the victims. Instead of the repetitive nature, the newly proposed theoretical definition puts more emphasis on three key elements of bullying, namely goal-directed behavior, a power imbalance, and victim harm, which are supported by theory and empirical research. In accordance, labeling bullying as "aggressive goal-directed behavior that harms another individual within the context of a power imbalance" (Volk, Dane, & Marini, 2014). Bullying occurs physically (e.g., kicking), verbally (e.g., name calling), relationally (e.g., gossiping), and occurs as cyberbullying (Craig et al., 2009).

The size of the problem is evident from the statistics on peer victimization. In Europe and North America on average approximately 30% of school students are occasionally victimized by schoolmates, whereas 10% are chronically victimized (Chester et al., 2015). In the Netherlands, a recent large-scale investigation showed 10% "occasional" victims and 2.5% chronic victims in primary education (Scholte, Nelen, de Wit, & Kroes, 2016). This means that there are two or three victims in a classroom of 25 students in school. Victims of bullying often have poor academic performance, poor social relations with others, and mental health problems in childhood and adolescence (e.g., high anxiety and depression) (Reijntjes, Kamphuis, Prinzie, & Telch, 2010). Fear of being bullied by school or classmates is also one of the major reasons why students miss school (Stam, Vreeburg-van der Laan, 2013).

In view of the detrimental effects of bullying, the effectiveness of measures to stop bullying behavior has been at best moderate, making it an ongoing concern for schools, teachers, and parents (for a review: Rivara & Le Menestrel, 2016). It is therefore important to understand when and under what conditions bullying is higher and persists in schools and classrooms. This thesis is aimed at gaining more insight into the processes underlying the incidence and development of bullying in primary education. The focus is on the classroom context.

1.2 The classroom context

The classroom is a relevant social context for studying bullying because students are

designated members of a particular classroom. Students spend most of their school time with their classmates, playing, talking, and working together. Naturally, students form interpersonal relationships with their classmates that are positive, such as friendship, helping or liking, or negative, such as disliking and perhaps bullying or victimization, or both.

In a large-scale study, it was found that 13% of total variation in victimization was due to classroom differences (Kärnä, Voeten, Poskiparta, & Salmivalli, 2010; Salmivalli, 2010). Classrooms also differ with regard to other bullying-related behaviors, such as reinforcing the bully and defending the victims (Kärnä et al., 2010). Although its relevance is widely acknowledged by bullying researchers, the classroom as a determinant of bullying is an understudied topic in bullying research (Juvonen & Graham, 2014; Salmivalli, 2010). I focus on classroom composition (referring to structure and stability) and climate (referring to friendship relationships and bullying norms).

Previous research considered bullying (Caravita, Sijtsema, Rambaran, & Gini, 2014; Merrin et al., 2018; Sentse, Kiuru, Veenstra, & Salmivalli, 2014; Sijtsema, Rambaran, Caravita, & Gini, 2014), victimization (Lodder, Scholte, Cillessen, & Giletta, 2016; Sentse, Dijkstra, Salmivalli, & Cillessen, 2013; Sijtsema, Rambaran, & Ojanen, 2013), and defending (Sijtsema et al., 2014; Ruggieri, Friemel, Sticca, Perren, & Alsaker, 2013) mainly as individual behavior. Notwithstanding the progress made in understanding individual bullying behavior, researchers increasingly recognize that bullying is relational, and that a relational approach allows for a more nuanced understanding of *who bullies whom in the classroom* (Rodkin, Espelage, & Hanish, 2015; Veenstra et al., 2007). This is also the approach taken in the four studies in this thesis. Bullying can be seen as a network relationship between two students (student *i* indicates another student *j* as his or her bully, in network analysis often called the (directed) tie from actor *i* to actor *j*) (Rodkin et al., 2015; Veenstra et al., 2007). Similarly, defending can also be seen as a network relationship (student *i* defends a specific victim *j*) (Sainio, Veenstra, Huitsing, & Salmivalli, 2011).

Figure 1.1 provides an illustration of both for just five students. They can be seen as a simplified snapshot of students' reports of the negative and positive interpersonal relationships with their classmates at a particular time point. In this illustration, two children, one girl (2) and one boy (4), have indicated to be bullied by the same boy (3). Both of these victims have also indicated to be defended (girl 1 defends girl 2 and boy 5 defends boy 4). This oversimplified version of a classroom network illustrates how behaviors related to bullying are directed toward specific peers, and that this relational aspect, *who bullies* (*defends*) *whom*, can be analyzed more precisely with a social network approach.

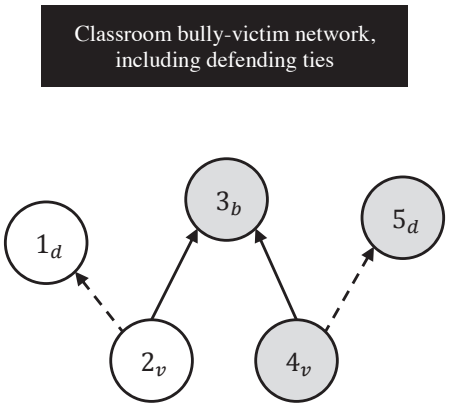


Figure 1.1 Illustration of a bully-victim network including defender nominations.
Network contains three boys (gray) and two girls (white), one bully (*b*), two victims (*v*), and two defenders (*d*; 1 among the girls and 1 among the boys).

Previous social network research used cross-sectional data to explain the network structure of bullying networks and defending networks with Exponential Random Graph Models (ERGMs at one time point; e.g., Huitsing & Veenstra, 2012; Huitsing et al., 2012; Huitsing & Monks, 2018; Oldenburg, van Duijn, & Veenstra, 2018). With longitudinal data, social network researchers are able to explain changes in the network structure of bullying networks and defending networks using Stochastic Actor Oriented Models (SAOMs using RSiena; e.g., Huitsing, Snijders, van Duijn, & Veenstra, 2014; van der Ploeg, Steglich, & Veenstra, 2019). The four social network studies in this thesis, two of which are cross-sectional using PNet (Wang, Robins, & Pattison, 2009) and two of which are longitudinal using RSiena (Snijders, van de Bunt, & Steglich, 2010), utilize the insights provided by previous social network studies, and advance them by investigating classroom factors.

In the following sections, I discuss the background and aims of each study. In the first part of the thesis, I examine the impact of classroom composition, by examining whether victimization depends on (relative) age differences or grade differences between children in classroom (Chapter 2) and whether victimization depends on stability and change in student classroom composition (Chapter 3). In this first part, I focus on victim-bully networks. In the second part, I take into account the interdependence of bullying and defending networks with other positive and negative network types, when examining the relation between friendship networks and victim-bully networks (Chapter 4) and the relation between (dis) liking networks and defending networks and whether the classroom bullying degree (classroom climate) affects this relation (Chapter 5). Figure 1.6 provides an overview of this.

The four studies in this thesis are part of a larger ongoing project on the consequences and antecedents of victimization in school. The data used in the four studies in this thesis come from the KiVa program in the Netherlands. These data have been used in other recent KiVa studies on a variety of important bullying research topics (e.g., networks of victimization: Huitsing et al., 2014; teachers and victimization: Oldenburg et al., 2015; intensity of victimization: van der Ploeg, Steglich, Salmivalli, & Veenstra, 2015; persistency in victimization: Kaufman, Kretschmer, Huitsing, & Veenstra, 2018).

KiVa is Finnish for "nice" and an abbreviation for the Finnish sentence "a nice school without bullying". The KiVa program was first introduced in Finnish schools in 2007-2008, and demonstrated to be effective in a large sample across grades 4 to 6 (Kärnä et al., 2011). KiVa not only reduced school bullying, but also significantly improved the social and mental health and well-being of victims. KiVa was also proven to be successful in other countries (e.g., Italy: Nocentini & Menesini, 2016; the UK: Hutchings & Clarkson, 2015).

Over a period of two years (May 2012 to May 2014), the KiVa experiment was implemented in 99 elementary schools in the Netherlands (Huitsing et al., 2019; Kaufman et al., 2018). As part of the experiment, the participating schools were randomly assigned by the Netherlands Bureau for Economic Policy Analysis (CPB) to either the control condition (34 schools) or to one of the two intervention conditions (33 in the KiVa condition and 32 in the KiVa+ condition). The KiVa+ condition received additional materials to reduce school bullying.

All data analyzed in this thesis come from the schools that were in the control condition in order to avoid that differences between classrooms (our context of analysis) were a result of the intervention, and to follow the "natural" process of bullying. It is important to note, however, that during the intervention period (2012-2014), bullying received intense media attention in Dutch society. This was guided by recent tragedies involving suicidal incidents that were directly related to the consequences of bullying.

1.2.1 Part I A: Classroom structure and peer victimization

As most schools across the world traditionally have single-grade classrooms, children in primary school classrooms typically interact within same-age peer groups (Mulyran-Kyne, 2005). However, some schools combine different grades within one group, so called multigrade or multi-age classrooms where children interact within mixed-age peer groups (Mulryan-Kyne, 2007; Veenman, 1995). Multigrade classrooms are common in the Netherlands, and are usually formed for administrative reasons when schools deal with low enrollment and/or uneven classroom sizes. A relatively small group of Montessori and Jenaplan schools deliberately combine grades or age groups for pedagogical purposes (Lillard & Else-Quest, 2006).

Most research on the effects of multigrade classrooms and multi-age classrooms (for reviews: Mulryan-Kyne, 2007; Veenman, 1995, 1996) found no significant differences between regular single-grade and multigrade or multi-age classrooms in terms of students' school performance. With regard to non-cognitive outcomes, however, students in multigrade and multi-age classrooms performed slightly better compared to students in single-grades on social adaptation to peers and school, and personal feelings of belonging and absence of anxiety.

Research into bullying and peer victimization has largely neglected age- or grade-mixing as a topic of study (Ellis et al., 2012) or did not describe their effects in detail. This is surprising because age or grade differences are a natural source of power imbalance, which is considered as a key feature of bullying (Salmivalli, 2010; Volk et al., 2014). To this end, in the second chapter of this thesis, I examine whether processes of power imbalance in peer victimization depend on (relative) age and grade differences between students in classroom.

I examine whether multigrade classrooms in comparison to single-grade classrooms are either a risk or a protective factor for peer victimization in childhood. Following a status framework (Rodkin et al., 2015), one could argue that due to a power imbalance younger children are more likely to be victimized in classrooms with larger age differences (Chaux & Castellanos, 2015), such as in multigrade classrooms. Alternatively, from an evolutionary perspective (Ellis et al., 2012), one could argue that such classrooms encourage prosocial behavior in children by providing and receiving help across age groups. This might result in lower risk of victimization for younger children by older children, particularly in multigrade classrooms that are formed for pedagogical reasons rather than administrative reasons. In the second chapter of this thesis, I examine the two competing perspectives by studying peer victimization in single-grade and multigrade classrooms.

1.2.2 Part I B: Classroom stability and peer victimization

Each year, schools undergo changes in their student population due to students who change grades normally (move one grade up), repeat a grade, skip a grade, or move houses. In addition, some students move to a different school, due to low academic achievement, behavioral problems, special learning needs, parents' or guardians' request, or other reasons (OECD, 2013). These changes greatly affect the stability in student classroom composition at school and, subsequently, children's positions in the classroom. I investigate how changes in classroom composition affect children's relationships. It is reasonable to expect that classroom composition changes have an influence on the interactions between students in the grade network because it reduces their opportunities to connect (Valente, 2012). On

the one hand, these changes may break up friendships, on the other hand, it may break up victimization relations and help reduce bullying.

Figure 1.2 provides an illustration of the well-structured change in classroom composition in pedagogical multigrade classrooms. This figure shows how third and fourth grade students transition over three school years. The students in both grades start in the same classroom in Year 1, are placed in two separate classes in Year 2, and end up in the same classroom again in Year 3. Here, third grade students first belong to the younger group (in Year 1), then to the older group (in Year 2), and are again in the younger group (in Year 3). Pedagogical multigrade schools expect that the younger children will receive help from the older children in their multigrade classroom, and provide help to younger children in turn when they are older themselves.

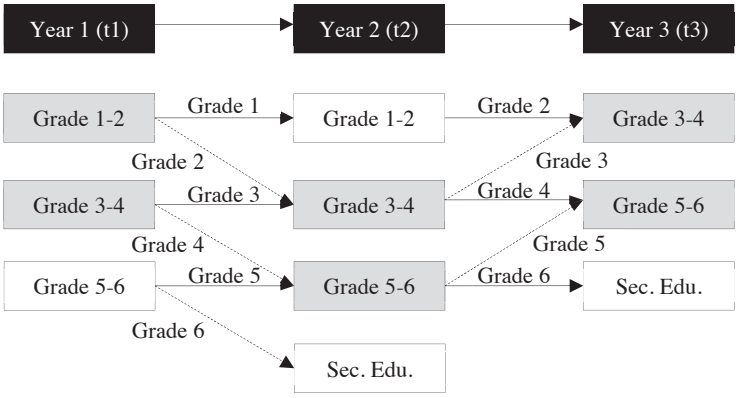


Figure 1.2 Transition of students in classes in a pedagogical multi-grade school.

Figure 1.3 provides an illustration of the less-structured change in classroom composition in a school that is unable to maintain a single grade structure for administrative reasons. This figure shows a school with both single-grade and multigrade classrooms. In this example, fourth grade students transition over three school years. Students start in the same classroom in Year 1. Their classroom is combined with the part of another fifth grade classroom in Year 2, to form a new combination classroom (5-6). In this particular case, the entire cohort of sixth graders has left the school (went on to secondary education), so that the group of fifth graders would be too small to form a separate classroom. In Year 3, the group of fourth graders in Year 1, now sixth graders, is combined again with a different group of fifth graders. At the same time, a new group of third graders joins the group of fourth graders who have been together since Year 1. In this example, the groups (referring to same classmates with the same grade) remain intact and classroom mixing occurs because classrooms are not completely filled.

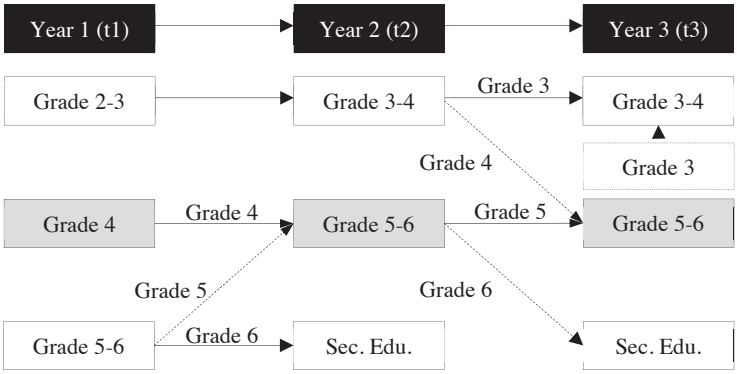


Figure 1.3 Transition of students in classes in an administrative multi-grade school.

Little is known about how changes in classroom composition affect bullying behavior and peer victimization. In an early study, it was found that the stability of bullying behavior was weaker in low-stability classrooms (Salmivalli, Lappalainen, & Lagerspetz, 1998). More recent studies found lower victimization among students who moved to a different location when transitioning to middle school compared to students who stayed in the same school (Farmer, Hamm, Leung, Lambert, & Gravelle, 2011a; Wang, Brittain, McDougall, & Vaillancourt, 2016). An explanation is that such transitions break up the dominance structures and the accompanying bullying. Bullying may also be the reason why children move to a different school. These findings suggest that stability and change in classroom composition impact negative behaviors, and possibly positive behaviors as well.

The third chapter in this thesis examines individual and dyadic effects that capture the complexity of stability and change in classroom composition and their impact on peer victimization. The expectation is that in a stable school or classroom context, children have a good sense of each other's social positions. This implies that once children have weak positions they are more likely to become a target of bullies. As this process confirms students' weak position, victimization is more likely among students who were in the same class before. In addition, newcomers in such schools are likely to start with a weaker position in the process of fitting in in the classroom and are more vulnerable targets of bullying. The individual – newcomer – and dyadic – same classroom – effects are examined in a sample of single-grade schools, where within-school classroom differences in terms of student classroom composition changes are small, and in multigrade schools, where students within the same school change classrooms more frequently.

1.2.3 Part II A: Classroom friendships and bullying/victimization

In the participant roles approach, bullying between a bully and victim takes place in the presence of peer witnesses who can assist or reinforce the bullies (Salmivalli, Lagerspetz, Björkqvist, Österman, & Kaukiainen, 1996). Earlier studies on bullying behavior and peer victimization found that friends tend to have similar involvement in bullying behavior and peer victimization (Espelage, Green, & Wasserman, 2007; Espelage, Holt, & Henkel, 2003).

Similarity in bullying behavior may be explained by a selection effect, such that bullies select each other as friends, or by a socialization effect, referring to that bullies influence their friends to become bullies (Salmivalli & Voeten, 2004). This is illustrated in Figure 1.4 A. With longitudinal network models (Snijders et al., 2010), these effects can be distinguished. Previous studies on the dynamic relation between friendship networks and individual bullying behavior found no convincing indication that bullies select each other as friends or that bullies influence their friends in adolescence (Caravita et al., 2014; Merrin et al., 2018; Sentse et al., 2014; Sijtsema et al., 2014). Yet, these studies did not take into account that bullying is relational. The fourth chapter in this thesis investigates peer selection and influence in specific targets and specific co-bullies instead of general bullying in childhood. This is illustrated in Figure 1.4 B.

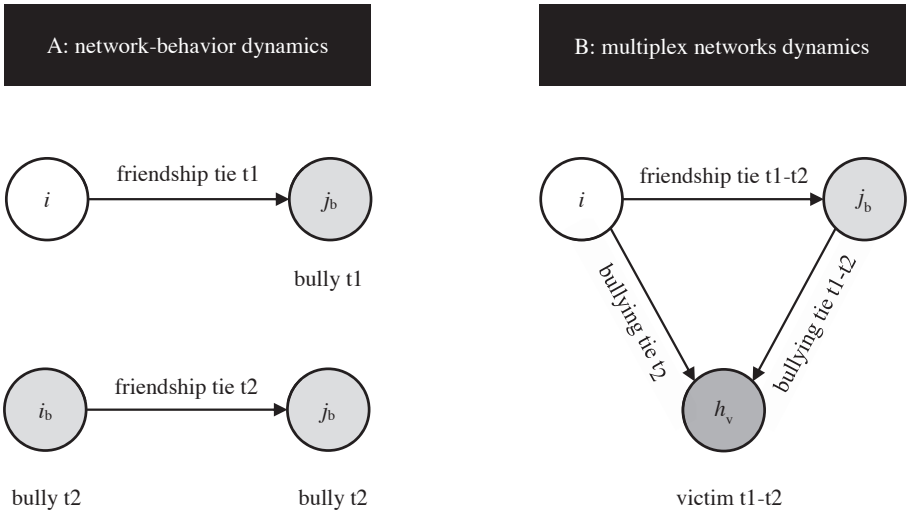


Figure 1.4 Two ways of examining influence processes using a social network approach.
Option 1: using bullying as individual behavior in conjunction with friendship (A)
Option 2: using bullying as network relationship in conjunction with friendship (B)

1.2.4 Part II B: Classroom bullying norms and defending

The final study in this thesis (Chapter 5), focuses whether the degree of victimization in the classroom facilitates or inhibits students' inclination to defend their victimized classmates. The degree of victimization is an indication of the bullying norm in the classroom (Salmivalli, 2010).

Children who defend victimized classmates fulfill an important role in bullying situations: they can actively support the victims, by confronting the bullies or by comforting the victims. Thus, they are able to mitigate the negative consequences of victimization (Sainio et al., 2011).

Most children do not approve of bullying and would like to help the victims (Boulton, Trueman, & Flemington, 2002; Rigby & Johnson, 2006; Rigby & Slee, 1991). Defending is nevertheless relatively uncommon. On average only about 1 in 5 students in classrooms defend victims and not all victims are defended by their peers (Salmivalli, 2010). An explanation for why defending is relatively rare is that potential defenders may be discouraged to intervene because they might fear to become the next victim (Pozzoli, Gini, & Vieno, 2012; Pozzoli & Gini, 2010), particularly in a classroom context where bullying is high (Meter & Card, 2015).

Previous research showed that if bullying is high in a classroom context, bullies are less rejected and more accepted by peers, whereas non-bullies are less accepted and more rejected by peers which suggests that the bullies in such a classroom have a dominant position (Sentse, Scholte, Salmivalli, & Voeten, 2007). Thus, students (bullies, victims, and non-victims) may perceive bullying as the classroom norm. Recent research also demonstrated that in pro-bullying classrooms children defend less (Peets, Pöyhönen, Juvonen, & Salmivalli, 2015), whereas in pro-victim classrooms children defend more (Yun & Graham, 2018).

Motivations for defending may not only be guided by individual factors in combination with the bullying norm (Meter & Card, 2015) but may also be shaped by interpersonal factors (Thornberg et al., 2012), such as considering others as a friend or (dis)liking a victim (Meter & Card, 2015). Recent research using a multiplex social network approach in a small sample of seven third-grade classrooms, found that children defended the classmates whom they befriended but not whom they disliked (Oldenburg et al., 2018). This suggests that children are selective in choosing the victims they defend, and are willing to accept the accompanied risks for someone they are socially invested in.

In Chapter 5, I addressed the following three main questions: (1) What is the relation between (dis)liking and defending? (2) Does the classroom bullying norm facilitate or inhibit students'

defending of victims? (3) Does the classroom bullying norm affect the relation between (dis)liking and defending? I answer these three questions using two analytical approaches, an individual and a social network approach. The individual approach (multilevel analysis) is widely used in studies on defending (e.g., Peets et al., 2015; Pozzoli et al., 2012; Pöyhönen, Juvonen, & Salmivalli, 2012; Pronk, Olthof, Goossens, & Krabbendam, 2019; van der Ploeg, Kretschmer, Salmivalli, & Veenstra, 2017; Yun & Graham, 2018) because it accounts for part of the nested structure of the data (individual students in classrooms). Unfortunately, an individual approach ignores the dependence due to the relational nature of defending (referring to *who defends whom*). This individual approach provides general information about students' defending behavior in classrooms (student *i* defends, irrespective of whom he or she defends), and its relation with liking and disliking by classmates (by victims and non-victims). A social network approach enables the full use of the available information. Thus, by using this approach I am able to examine (1a) the co-occurrence of defending and direct (dis)liking relations (see Fig. 1.5 A), (1b) the co-occurrence of defending and shared (dis)liking relations (see Fig. 1.5 B), and (2) the effect of the bully norm in the classroom.

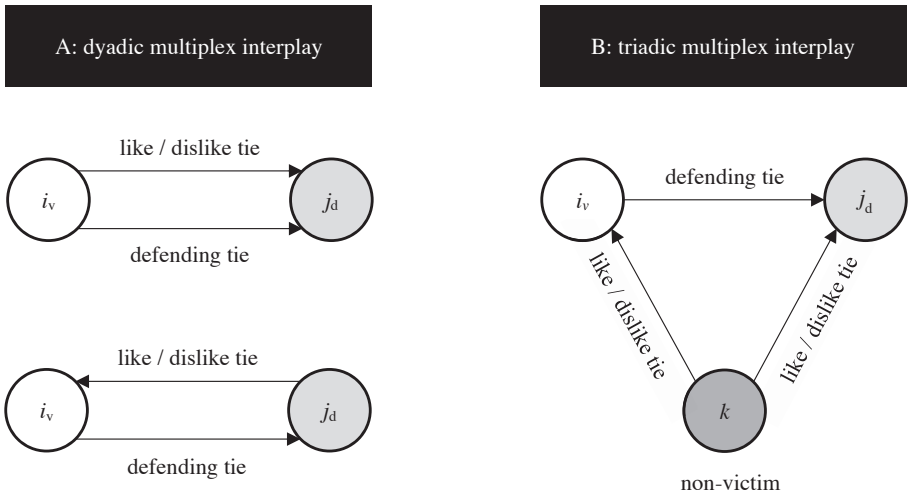


Figure 1.5 Illustration of the main hypothesized effects using a social network approach.
Left: direct effects of co-occurrence of liking/disliking with defending (A)
Right: indirect effects of co-occurrence of liking/disliking with defending (B)

After the four chapters there is a chapter with conclusion and discussion, in which the answers to the research questions posed in Figure 1.6 are given.

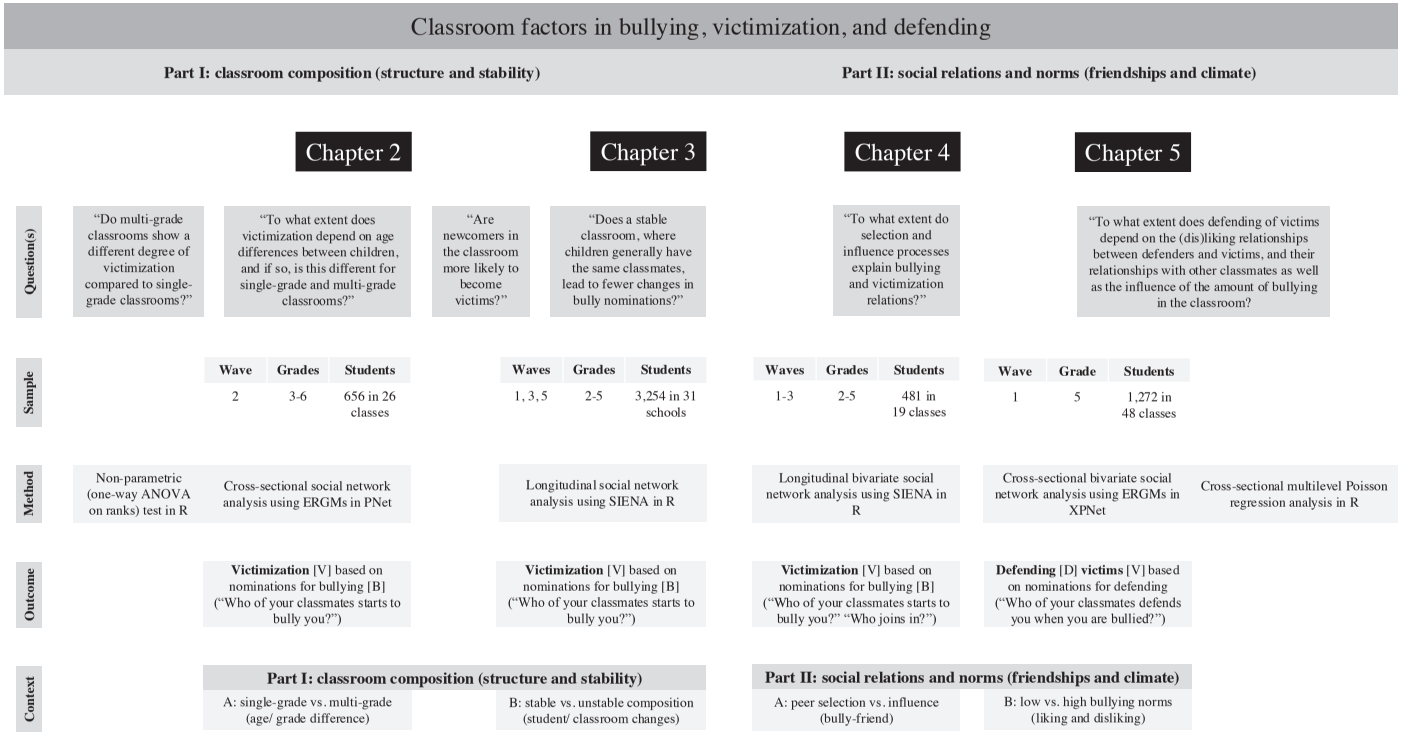
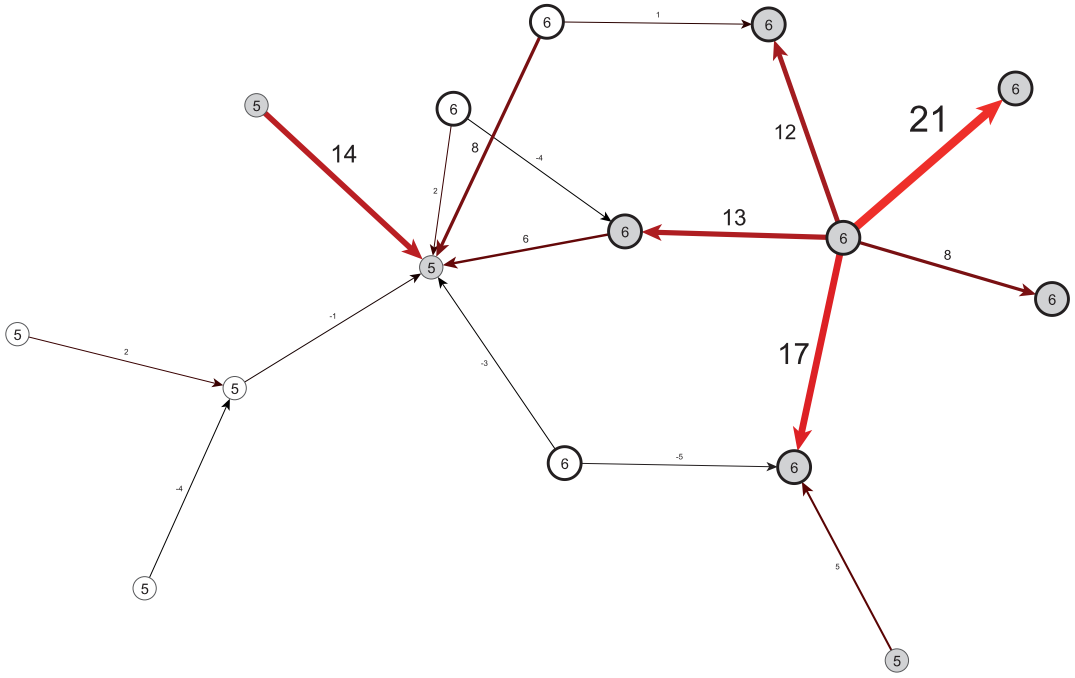


Figure 1.6 Overview of the four empirical chapters in this thesis.

Chapter 2

Peer Victimization in Single-Grade and Multigrade Classrooms



This chapter is based upon:

Rambaran, J.A., van Duijn, M.A.J., Dijkstra, J.K., & Veenstra, R. (2019). Peer Victimization in Single-Grade and Multigrade Classrooms. *Aggressive Behavior*, *45,* 561-570. doi:10.1002/ab.21851

Although peer victimization mainly takes place within classrooms, little is known about the impact of the classroom context. To this end, it was examined whether single-grade and multigrade classrooms (referring to classrooms with one and two grades in the same room) differ in victim-bully relationships in a sample of elementary school children (646 students; age 8-12 years; 50% boys). The occurrence of victim-bully relationships was similar in single-grade and multigrade classrooms formed for administrative reasons, but lower in multigrade classrooms formed for pedagogical reasons. Social network analyses did not provide evidence that victimization depended on age differences between children in any of the three classroom contexts. Moreover, in administrative multigrade classrooms, cross-grade victim-bully relationships were less likely than same-grade victim-bully relationships. The findings did not indicate that children in administrative multigrade classrooms are better or worse off in terms of victim-bully relationships than children in single-grade classrooms are.

Keywords: social networks; victimization; dominance; evolutionary; classroom context

2.1 Introduction

Peer victimization is a pervasive and reoccurring societal problem: it is repeatedly shown that it mainly harms those who are socially the most vulnerable in school (Farris & Felmlee, 2011; 2014) and comes with a high cost as victims suffer from social, emotional, and physical health problems (for an overview, see Rivara & Le Menestrel, 2016). Increasingly, researchers have come to recognize the important role of classroom characteristics in victimization (Juvonen & Graham, 2014), and realize that peer victimization depends on the characteristics of the bully, the victim, and the social context (Volk, Camilleri, Dane, & Marini, 2012; Salmivalli et al., 1996).

The classroom provides both a context and a frame of reference in which social dominance hierarchies are established based on social interactions between children (Farmer, Lines, & Hamm, 2011b). These interactions typically take place within same-age peer groups as most school children across the world are traditionally organized in single-grade classrooms

(Mulryan-Kyne, 2005). However, interactions can also take place within mixed-age peer groups as schools increasingly combine different grades within one group, so-called multigrade classrooms (Mulryan-Kyne, 2007; Veenman, 1995). Thus far, research into peer victimization has neglected age-mixing as a topic of study (Ellis et al., 2012). This is surprising because age differences are a natural source of power imbalance, which is one important feature of bullying (Salmivalli, 2010). The multigrade classroom provides the opportunity to investigate whether peer victimization depend on age differences between classmates as it provides a context where age differences between the children are larger than in single-grade classrooms.

Two perspectives may explain peer victimization. Following a status framework (Rodkin et al., 2015), it can be argued that because of a power imbalance younger children are more likely to bully or be victimized in classrooms with larger age differences (Chaux & Castellanos, 2015), such as in multigrade classrooms. Alternatively, from an evolutionary perspective (Ellis et al., 2012), it can be argued that multigrade classrooms encourage prosocial behavior in children, resulting in a lower risk of victimization for younger children by older children, particularly in multigrade classrooms formed for pedagogical reasons rather than administrative reasons. In this study, we distinguish between the two classroom types because pedagogical multigrade classrooms aim to stimulate prosocial relations among children by encouraging the provision of help across grades within the same classroom (Lillard & Else-Quest, 2006; Gray, 2011), whereas administrative multigrade classrooms do not have such an explicit goal.

Currently, it is unclear whether multigrade classrooms in comparison to single-grade classrooms are either a risk or protective factor for peer victimization in childhood. We aim to explore the two competing perspectives by examining victim-bully relationships in single-grade and multigrade classrooms in a sample of elementary school children. Investigating classroom differences is an important direction in bullying research as a better understanding of the role of age differences in the classroom may help to advance prevention or intervention policies.

2.2 Theory

2.2.1 A status framework

One perspective toward explaining peer victimization is the status framework (Rodkin et al., 2015), which posits that victimization is targeted peer aggression within the context of a relationship of power and abuse. In such relationships of power imbalance, bullies are

aggressors repeatedly targeting socially vulnerable individuals to maintain or gain a high social status (Salmivalli, 2010; Veenstra, Lindenberg, Munniksma, & Dijkstra, 2010). Victims of peer bullying thus suffer from their disadvantaged and isolated position in the group as they form easy targets because of their low status (Farmer et al., 2011b). In this perspective, bullying is instrumental to acquire social resources and to maintain dominance over marginalized peers (Rodkin et al., 2015), and to demonstrate self-esteem and social skills (Guerra, Williams, & Sadek, 2011). This further enhances the bullies' positions in the group and weakens the positions of victims.

Age forms an important aspect through which social dominance hierarchies can be determined in classrooms (Ellis et al., 2012). As children grow older, they become socially, cognitively, and physically more developed (Piaget, 1953). Older children thus have a clear advantage over younger children, to obtain dominant positions in the group. They may use this advantage by targeting younger children to demonstrate social dominance. Younger children compared to older children are more vulnerable for peer victimization (Barker et al., 2008; Chaux, Molano, & Podlesky, 2009; Rivers & Smith, 1994; Scheithauer, Hayer, Petermann & Jugert, 2006) as they are more likely to have a weaker social position in the peer group (Salmivalli, 2010). This suggests that younger children are an easy target for older children.

It makes sense that an effect of power imbalance through age would be more salient in a context with a large age-range. In contrast to single-grade classrooms where an age difference between the children of one year is usually the maximum to be expected, children in multigrade classrooms differ up to the number of grades combined in the classroom. Considering that students spend most of their time in school within the same classroom, this means that in single-grade classrooms, social interactions mostly take place in same-age groups, whereas in multigrade classrooms they also take place among children who clearly differ in age. Researchers have argued that as a consequence of age-mixing, multigrade classrooms may produce peer hierarchies based on students' age and thus, putting younger children at risk for victimization (Kolbert & Crothers, 2003). Hence, in multigrade classrooms older children may target younger children as a means to demonstrate dominance.

Following this line of reasoning, we expected that power imbalance is more related to age differences in multigrade classrooms compared to single-grade classrooms, and, therefore, in multigrade classrooms we expected to find higher degrees of victimization (H1a), and higher risk of victimization for younger children targeted by older children than vice versa, higher risk of victimization for older children targeted by the younger children (H2a). In multigrade classrooms, we can separate the age difference in a grade effect and a relative age difference, whereas in single-grade classrooms only the (relative) age difference can be examined.

2.2.2 An evolutionary model

The evolutionary model of risky child/adolescent behavior provides an alternative perspective toward explaining peer victimization in classrooms (Ellis et al., 2012). This model posits that mixed-age settings, rather than age-segregated school and peer environments, are the natural context for child development. The presence of both older and younger children in mixed-age settings provides a natural hierarchy based on age. In this context, both older and younger children settle with their position in the social group, which decreases the tendency to compete for dominance and status by demonstrating aggressiveness. Evolutionary psychologists argue that older children can serve as positive role models, and that the positive association between status and prosocial behavior reduces the need to gain status through antisocial means (Ellis et al., 2012). The research findings show that when older children are assigned to younger children as caregivers, buddies, or playmates, they tend to behave less aggressive and more prosocial toward younger children and same-age peers in other contexts as well (Ember, 1973; Gray, 2011). In addition, the findings suggest that children in mixed-age school settings interact socially across wide age ranges; older children and younger children associate with each other, and become friends with each other (Pratt, 1986; Miller, 1990). In sum, this research suggests that the presence of younger children in mixed-age settings reduces aggression and promotes nurturance and compassion in children (Gray, 2011). In contrast, age-segregated school and peer environments, such as single-grade classrooms, have been argued to evoke aggression and conflict in children, and, in such a classroom context, children may actively search for dominance (Ellis et al., 2012).

There are two reasons why multigrade classrooms are formed within schools (Veenman, 1995). First, schools deliberately form such classrooms for didactic and pedagogical purposes, for instance to enhance the classroom climate. An example of such schools is Montessori schools, which are characterized by a special set of educational materials, freedom as a student to choose own activities, collaboration between students, and individual and small group instruction in both academic and social skills (Lillard & Else-Quest, 2006). Second, schools tend to form such classrooms for administrative reasons, for example, when dealing with low enrollment and uneven classroom sizes. It is important to make a distinction between these two forms of multigrade classrooms as the basis for their formation may yield different outcomes with regard to the victim-bully relationships. Particularly pedagogical multigrade classrooms are argued and shown to have more positive outcomes because promoting prosocial behavior between the older and younger children in such classrooms is part of the school's educational philosophy (Lillard & Else-Quest, 2006; Moller, Forbes-Jones, & Hightower, 2008). By contrast, teachers in administrative multigrade classrooms were generally found to teach the grades separately (Veenman, 1995; Mulryan-Kyne, 2007; but

see Mason & Burns, 1996), which decreases opportunities for prosocial behavior between older and younger children as such multigrade classrooms emphasize individualized work and do not necessarily encourage between-grade interactions (Juvonen, 2018).

Following this line of reasoning, we formulated two additional hypotheses. In pedagogical multigrade classrooms, we expected to find lower degrees of victimization (H1b) and lower risk of victimization for children targeted by older children than vice versa, higher risk of victimization targeted by older children (H2b).

2.3 The present study

We investigate victim-bully relationships in single-grade and multigrade classrooms. We address two main questions: (1) Do multigrade classrooms show a different degree of victimization compared to single-grade classrooms? (2) To what extent does victimization depend on age differences between children, and if so, is this different for single-grade and multigrade classrooms? We focused on middle to late childhood, because in that period social dominance hierarchies are established through school bullying (Kolbert & Crothers, 2003). We controlled for sex, because boys are often more dominant and aggressive toward peers than girls (Ellis et al., 2012; Volk et al., 2012).

2.4 Method

2.4.1 Sample

Classrooms were drawn from the second wave of the KiVa study at the start of the school year (in October 2012). KiVa is a program aimed to reduce school bullying among children from grades 3-6 in elementary education (8-12 years) in the Netherlands (Kaufman et al., 2018; Huitsing et al., 2019). The 99 participating schools (66 intervention and 33 control schools) contained 25 schools with only single-grade classrooms, 39 schools with only administrative multigrade classrooms, 14 schools with only pedagogical multigrade classrooms, and 21 schools with both single-grade and administrative multigrade classrooms.

Selection of classrooms

Figure 2.1 shows the selection criteria that were used in the present study. Only control schools were selected for the analysis to avoid that differences between classrooms were a result of the intervention. Schools were selected that had either only single-grade classrooms or only multigrade classrooms to avoid potential differences due to a mixed-

school setting. Seven schools in the control condition formed both single-grade classrooms and multigrade classrooms ("mixed-school settings") and were excluded from the sample. Schools with multigrade classrooms had either two or three grades in the same classroom. Because schools with only single-grade classrooms participated with grades 3-6, we excluded multigrade schools with grades 1-2. As can be seen in Table 2.1, most multigrade classrooms were grade 3-4 or grade 5-6 combinations. Therefore, we excluded multigrade classrooms with a different grade combination. Because the remaining administrative multigrade schools each had four grades (3-4 and 5-6), we excluded single-grade schools with more than 4 grades.

For the remaining 14 schools, containing 38 classrooms, we applied an additional set of selection criteria for classroom's eligibility for social network analysis: first, classroom size should be larger than 15. Smaller classrooms are hard to compare to the more common larger classrooms and tend to carry less information which complicates the statistical social network analysis; and second, the combinations for sex (boy-boy, girl-girl, boy-girl, and girl-boy) and grade (low-low, high-high, low-high, high-low) should contain victimization relationships for the reference category. The latter criterion was needed for estimating the sex and grade effects comparable across classrooms. We chose boy-boy (meaning boys nominating other boys as their bully) and low-low (meaning lower-grade classmates nominating other lower-grade classmates as their bully) as reference.

The two selection criteria resulted in dropping 12 classrooms (see for details Figure 2.1). The final sample consisted of 26 classrooms with 646 students (see Figure 2.1), of which 11 single-grade classrooms (n = 274), 9 administrative multigrade classrooms (n = 216), and 6 pedagogical multigrade classrooms (n = 156). Information about the school's pedagogical background was provided by the school office, and was used to categorize the schools into the three categories.

In our subsample of 646 students, 324 (50.2%) students were boys (322 were girls; 49.8%) and the average age of the sample was 10.2 years (SD = 1.2). Most students (n = 529; 81.9%) were native Dutch; 16.7% were non-Dutch, 1.4% was missing because nine children provided insufficient information about their parent's ethnic background.

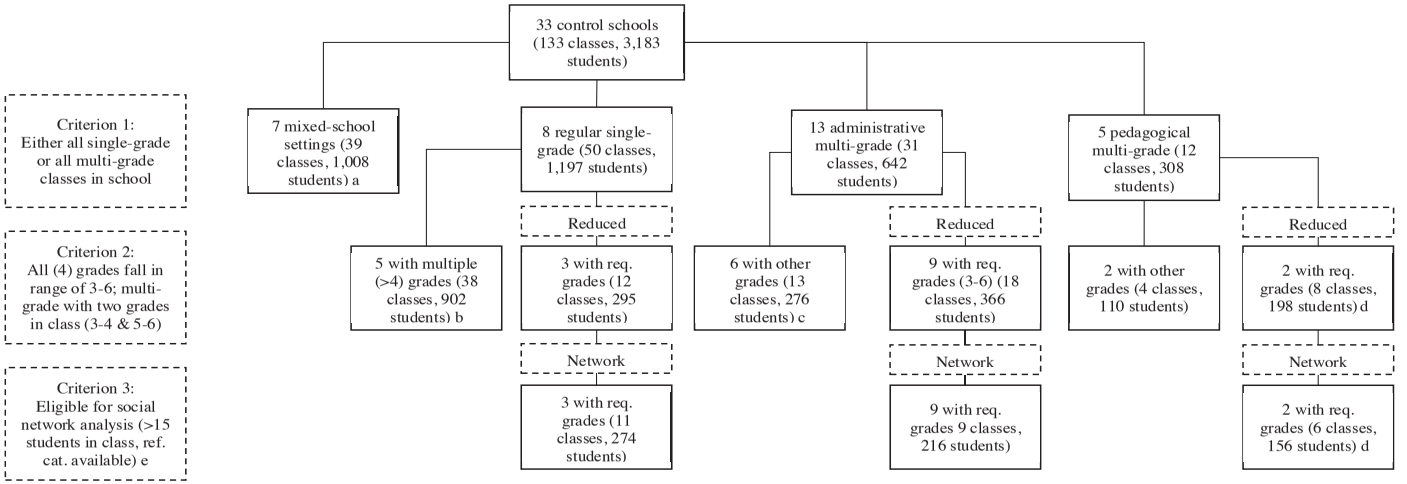


Figure 2.1 Schematic overview of the selection criteria.

Notes. a=Schools with a mixed-setting had both single-grade classrooms (at least one) and multi-grade classrooms (at least one); b=Schools had multiple single-grades (> one grade 3, 4, 5 or 6); c=Schools had many different not so straightforward other combinations (e.g., 2-3, 4-5, 1-3, 4-6; see Table B1). To ensure comparability with single-grade classrooms (equal amount of four grades in schools: 3-6), we omitted these schools; d=One classroom (28 students) had a different combination (4-5) and was left out; e=six classrooms had incomplete sex combinations (1 single-grade; 2 administrative multi-grade; 1 pedagogical multi-grade) or grade (1 administrative multi-grade; 2 pedagogical multi-grades). Six other classrooms (all administrative multi-grades) contained less than 15 students.

Differences between the samples

Table 2.1 provides an overview of differences between the full sample, reduced sample, and final network sample. Average density (proportion of nominations given) between the full and the final network sample was similar for both single-grade classrooms (.040 versus .038) and pedagogical multigrade classrooms (.020 versus .021), but somewhat higher for administrative multigrade classrooms (.031 versus .042). The reason for this is because school classrooms with grade 1 and/or grade 2 had low to zero density, lowering the average density in the full sample.

Table 2.2 shows an overview of the differences in network features between the reduced and the final network sample. As can be seen in Table 2.2, the distribution of ties varied between the networks within each classroom type (referring to regular single-grade, administrative multigrade, and pedagogical multigrade). It did not vary much between the three classroom types nor between the full sample and reduced sample. The same holds for basic structural networks patterns: The average numbers of sinks (referring to students who are bullies but not victims), sources (students who are victims but not bullies), and isolates (referring to students who are neither victims nor bullies) were similar between the two samples. More complex structural network patterns – geodesic distances (indirect ties), reciprocity (victim-bully ties), and transitivity (cohesion) – were hardly present in the data. This is common for negative networks in general and peer victimization networks in specific (Huitsing et al., 2012; Huitsing & Veenstra, 2012). This indicates that victimization ties were mostly directed and unilateral. In sum, overall the differences between the two samples were not large.

2.4.2 Procedure

Students filled in an Internet-based questionnaire in their classroom during regular school hours. The process was administered by the teachers, who were present to answer questions and to assist the students when necessary. Prior to the data collection, teachers were given detailed instructions concerning the administration of questionnaires to students. During the data collection, support was available through phone and e-mail.

At the beginning of the questionnaire, students received information about the goal of the study, and how to fill in the questionnaire. They were told not to talk to each other or to discuss their answers when they filled out the questionnaire or afterward to ensure each other's privacy. It was explained to students that their answers would remain confidential. The teachers ensured that students who could not complete the questionnaire on the day of the data collection participated at another day within a month.

Table 2.1 Overview of differences between the full sample, reduced sample, and the final network sample.

Sample description	Full sample (33 schools, 133 classrooms)				Reduced sample (14 schools, 38 classrooms)				Network sample (12 schools, 26 classrooms)			
	No. of students	No. of classes	M class size	Av. density	No. of students	No. of classes	M class size	Av. density	No. of students	No. of classes	M class size	Av. density
Regular single-grade	1,807	74	24	.040	295	12	25	.036	274	11	25	.038
Grade 3	450	18	25	.047	74	3	25	.025	74	3	25	.025
Grade 4	436	18	24	.046	84	3	29	.038	84	3	28	.038
Grade 5	416	17	24	.041	66	3	23	.062	66	3	22	.062
Grade 6	505	21	24	.030	71	3	24	.019	50	2	25	.022
Administrative multigrade	1,040	46	23	.031	366	18	20	.049	216	9	24	.042
Grade 1-3	22	1	22	.000	-	-	-	-	-	-	-	-
Grade 2-3 [a]	89	4	22	.015	-	-	-	-	-	-	-	-
Grade 2-4 [a]	27	1	27	.028	-	-	-	-	-	-	-	-
Grade 3-4	263	13	20	.054	160	9	18	.066	88	4	22	.052
Grade 4-5	133	5	27	.029	-	-	-	-	-	-	-	-
Grade 5-6	407	17	24	.026	206	9	23	.033	128	5	26	.033
Grade 1-2-3 [a]	16	1	16	.000	-	-	-	-	-	-	-	-
Grade 2-3-4 [a]	17	1	17	.000	-	-	-	-	-	-	-	-
Grade 4-5-6	66	3	22	.017	-	-	-	-	-	-	-	-
Pedagogical multigrade	336	13	26	.020	198	8	25	.018	156	6	26	.021
Grade 3-4	94	4	24	.025	94	4	24	.025	78	3	26	.030
Grade 4-5	28	1	28	.012	-	-	-	-	-	-	-	-
Grade 5-6	104	4	26	.011	104	4	26	.011	78	3	26	.012
Grade 1-2-3 [a]	23	1	23	.006	-	-	-	-	-	-	-	-
Grade 4-5-6	87	3	29	.032	-	-	-	-	-	-	-	-

Notes. [a]No data available for Grade 1 and Grade 2 because they did not participate in the study. Accordingly, the low average densities for these multigrade classrooms may be due to absent network data, and therefore these classrooms cannot be used for comparison. Table 2.2 shows the difference between the reduced and network sample.

Table 2.2 Overview of network distribution differences between the reduced sample and the final network sample.

	Reduced sample			Network sample		
	Regular single-grade (12 classes)	Administrative multigrade (18 classes)	Pedagogical multigrade (8 classes)	Regular single-grade (11 classes)	Administrative multigrade (9 classes)	Pedagogical multigrade (6 classes)
Skewness (min-max)						
Av. in/out-degree	0.8 (0.2-2.0)	0.8 (0.0-1.7)	0.4 (0.2-1.1)	0.9 (0.2-2.0)	0.9 (0.4-1.7)	0.5 (0.2-1.1)
Av. st.dev. in-degree	1.2 (0.5-2.3)	1.1 (0.4-2.4)	0.8 (0.5-1.4)	1.2 (0.5-2.3)	1.3 (0.8-2.3)	0.9 (0.5-1.4)
Av. st.dev. out-degree	1.6 (0.6-3.0)	2.0 (0.9-4.0)	0.9 (0.4-1.9)	1.6 (0.6-3.0)	2.5 (1.7-4.0)	1.0 (0.5-1.9)
Av. skew of in-degree	1.6 (-0.1-2.4)	1.4 (0.0-2.6)	2.5 (1.6-3.3)	1.5 (-0.1-2.4)	1.6 (0.7-2.6)	2.4 (1.7-3.3)
Av. skew of out-degree	2.2 (0.8-4.4)	2.1 (1.1-4.7)	2.4 (1.6-3.3)	2.1 (0.8-4.4)	2.2 (1.1-3.0)	2.4 (1.7-3.3)
Structural configurations (min-max)						
Av. no. of sinks	7 (4-12)	6 (3-14)	5 (2-9)	7 (4-12)	7 (3-11)	6 (3-9)
Av. no. of sources	4 (1-9)	4 (1-8)	6 (3-12)	5 (1-9)	5 (2-8)	7 (4-12)
Av. no. of isolates	11 (3-16)	8 (0-20)	12 (3-22)	10 (3-16)	9 (3-20)	11 (3-22)
Geodesic distances (min-max)						
Av. 0 intermediaries (direct ties)	20 (5-39)	16 (2-38)	10 (3-24)	21 (5-39)	21 (11-38)	12 (5-24)
Av. 1 intermediary (indirect ties)	9 (0-52)	8 (0-38)	4 (0-16)	10 (0-52)	15 (0-38)	6 (0-16)
Av. 2 intermediaries	2 (0-20)	1 (0-13)	0 (0-2)	3 (0-20)	3 (0-13)	1 (0-2)
Av. 3 intermediaries	1 (0-8)	0 (0-1)	0 (0-0)	1 (0-8)	0 (0-1)	0 (0-0)
Reciprocity (min-max)						
Av. no. of reciprocity (mutual ties)	1 (0-5)	1 (0-3)	0 (0-1)	1 (0-5)	1 (0-3)	0 (0-1)
Transitivity (min-max)						
Av. transitivity (%)	3.2 (0.0-14.1)	2.3 (0.0-7.41)	2.0 (0.0-6.3)	3.5 (0.0-14.1)	3.0 (0.0-7.41)	2.7 (0.0-6.3)

Notes. Sinks (actors with zero out-degree). Sources (actors with zero in-degree). Isolates (actors with zero out-degree and zero in-degree); percentages may not match due to rounding differences. Geodesic distance = shortest path between two nodes; The density of transitive triples is the number of triples (of any form; see Wasserman & Faust, 1994) which are transitive divided by the number of paths of length 2, referring to the number of triples which have the potential to be transitive. Transitivity was calculated in Ucinet 6 version 6.459 (Borgatti, Everett, & Freeman, 2002).

Prior to the first wave (the pre-assessment) of the KiVa study (and for students who were new in school, after the first wave), schools sent information letters to students' parents. A passive consent procedure allowed students or parents to opt out of students' participation. At the start of data collection (2012), universities in the Netherlands did not require IRB permission for this type of research. All procedures performed were in accordance with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. A few students did not want to participate; also a few parents objected to their child's participation. Accordingly, for the whole sample at the second wave of the KiVa study participation rate was high (96%).

In an instructional movie, a professional actress explained to students what bullying means, using the following text: "Bullying is when some children repeatedly harass another child. The child who gets bullied has problems defending itself against this. Bullying is not the same as having a fight between two people who are equally strong. Bullying should also not be confused with joking around. Bullying is treating someone repeatedly in a mean way." Several examples of bullying were given to students, including physical and material forms (e.g., hitting someone, kicking or pinching; stealing or damaging someone's belongings) and relational and verbal forms (e.g., making fun of someone, calling names, saying mean things; gossip about someone; excluding from social activities).

2.4.3 Measures

Dependent variable

Peer victimization (bullying perpetration) was measured with network nominations following a two-stage procedure. Students were first asked to indicate how often they were victimized in general in the previous months (since the summer break), according to Olweus' (1996) self-reported bully/victim items, and, to indicate this for specific form(s) of victimization; physical harm (e.g., kicked), verbal harm (e.g., name calling), relational harm (e.g., gossiping), and cyber victimization. Answers were given on a five-point scale: "Not at all" (1), "Once or twice" (2), "Two or three times a month" (3), "Once a week" (4), and "Several times a week" (5).

When participants indicated that they were victimized by classmates at least "Once or twice" (score 2) on any item, they were presented with a roster showing the names of all classmates, and asked by whom of their classmates they were victimized (referring to "Who starts bullying you?"). Bully nominations were measured as either present (1) or absent (0). Students who indicated not being victimized by classmates did not fill out the nomination question. Their "answers" were considered as "structural missing" (no outgoing nomination possible). This means that victims were the only one "allowed" to send a bully nomination to classmates, but that everyone could receive a bully nomination. Victim-bully networks were obtained based

on all bully nominations in a particular classroom (from the victim's perspective).

Independent variables

We included *sex* (1 = boy). Students' *grade* was obtained from the school's office. The multigrade classrooms in our study included two grades in each classroom (3-4 or 5-6); students were categorized as belonging either to the lower grade or to the higher grade in their classroom. Students' birth dates were also obtained from the school's office. Age was derived from birth date and measured in number of months. We computed *relative age* by subtracting the median age in the classroom (calculated among all students in the classroom) from students' own age. Relative age in multigrade classrooms was obtained by subtracting 12 months from the higher-grade students' age, to compensate for a 1-year age difference between the two grades. This way, children's age in single-grade and multigrade classrooms were made comparable in order to separate grade differences from (relative) age differences.

2.5 Analytic strategy

The investigation of the victim-bully relationships in single-grade and multigrade classrooms in elementary school was done with two analyses. We tested our first set of hypotheses (H1a and H1b) using nonparametric analysis using Kruskal-Wallis *H* tests, and our second set of hypotheses (H2a and H2b) using cross-sectional social network analysis using ERGMs (Exponential Random Graph Models; Lusher, Koskinen, & Robins, 2013). The Kruskall-Wallis test is used to test differences in the median scores of tie percentage at the classroom level (average in-degrees) across the three classroom types (single-grade, administrative multigrade, and pedagogical multigrade). ERGMs can be used to analyze cross-sectional social network structures (Robins, 2015), and have been used before to examine victim-bully relationships (Huitsing et al., 2012). This choice allows us to simultaneously investigate individual and dyadic age and grade effects while explicitly taking into account the dependencies in the victim-bully network.

Cross-sectional social network analysis was done in PNet (Wang et al., 2009), a software program for the statistical analysis of social network data using ERGMs. The effects were first analyzed per classroom network and were then meta-analyzed in R with classroom-type as "explanatory variable" (referring to a mixed-effects model in metafor; Viechtbauer, 2010). Each classroom network was estimated with the same model specification. For some classroom networks, however, some parameters were left out, because the accompanying statistics (network configurations) were not there. The usual criteria for convergence (absolute value of *t*-statistics below 0.10 for all parameters; see Wang et al., 2009) was

obtained for all classroom networks. Table S2.1 in the Supplements provides Goodness of Fit (GoF) statistics. As shown, classroom networks adhered to the usual criteria for acceptable GoF statistics (absolute value of *t*-statistics below 2). In four classrooms (7, 8, 12, and 23), the fit was not optimal for the reciprocal age-related effects. Because we already included non-reciprocal age effects, including additional age effects resulted in non-convergence.

2.5.1 Model specification

To adequately capture important features of the victim-bully networks, we followed previous research in choosing the structural parameters in the exponential random graph models (Huitsing et al., 2012; Huitsing & Veenstra, 2012), using alternating or geometrically weighted versions of the structural statistics. *Density* indicates the general occurrence of victimization ties, comparable to the intercept or grand mean in (generalized) linear models. The *isolates* parameter indicates the occurrence of a network configuration where a child does not send or receive bully nominations to and from others (non-involvement), whereas the *sinks* parameter indicates the occurrence of a configuration where a child receives a bully nomination but does not send a nomination (referring to bullies who are not victims themselves). The *multiple two-paths* parameter reflects a bully-victim, referring to a child receiving a bully nomination and sending one. The *in-ties spread* parameter represents variability in receiving nominations as a bully, whereas the *shared in-ties* parameter represents variability in sending bully nominations by some children attracting more ties than others. If a structural parameter is significant, this indicates that the structural configuration occurs more frequently than if ties would be formed at random. We included sex as a covariate by specifying dyadic covariates indicating the sex combinations (taking the boy-boy dyad as the reference category).

To test the hypotheses H2a and H2b, individual and dyadic age and grade effects were included in the models. Thus, the effect of age difference is separated in three components that are comparable over the three classroom types, distinguishing differences due to relative age or grade, while controlling for a "main" or general age effect by a receiver effect of the relative age of the child. Note that no grade difference is defined for the single grade classrooms.

2.6 Results

2.6.1 Descriptive findings

Table 2.3 presents the summarized descriptive findings of the three types of classrooms. Bully nominations were, on average, almost twice as low in pedagogical multigrade classrooms (av. degree = .5) compared to both single-grade classrooms and administrative

multigrade classrooms, which were comparable in degrees of victimization (av. degree = .9).

Table 2.3 also shows on average higher bullying involvement with boys: they nominated mainly each other as bully, and were also nominated as bully by girls. More details are in Figure 2.2, which shows an overview of the distribution of the classroom network density based on sex, sorted by classroom type (referring to regular single-grade, administrative multigrade, and pedagogical multigrade). The figure above shows the densities per classroom for the younger cohort group (grade 3-4); the figure below shows the densities for the older cohort group (grade 5-6). Victimization among boys ('boy victimize boy') occurred in every classroom, whereas victimization among girls occurred in most but not all school classrooms. In most classrooms, victimization was higher among boys than among girls (with a few exceptions). Also, in most classrooms, boys victimized girls more than vice versa (with a few exceptions).

In multigrade classrooms, bully nominations occurred mainly among same-grade students: most students indicated that they were being victimized by a peer in their own grade (see av. densities for low-low group and high-high group in Table 2.3). More details are in Figure 2.3, which shows an overview of the distribution of the classroom network density based on grade, again sorted by classroom type. In most classrooms victimization occurred among same-grade students (with some exceptions). In addition, victimization was somewhat higher among the younger cohort group (Grade 3-4) than among the older cohort group (Grade 5-6). In half of the classrooms (7 times) higher-grade students victimized lower-grade students more than vice versa; the opposite was true in the other half of the classrooms (5 times); in three classrooms higher-grade students and lower-grade classrooms victimized each other to an equal extent.

Age

Figure 2.4 shows the summarized distribution of victimization based on age, separated by cohort and classroom type. The figure shows the summarized differences in age between victims' bullies and victims' non-bullies. The dashed line represents the mean age in a classroom. The part above and below the dashed line represent respectively children who are being victimized by older and younger children in classroom (relative to those by whom they are not victimized). The difference centers around zero which indicates that children who bully others are not older than children who do not bully others. That is, the Figure shows the relative age differences between victims' bullies and victims' non-bullies, showing no clear pattern as children were victimized approximately equally often by older and younger classmates, except for the pedagogical 5-6 grades, where victims more often had older bullies.

Table 2.3 Overview of the single-grade and multigrade classrooms included in this study.

		Regular single-grade	Administrative multigrade	Pedagogical multigrade
Sample description (classes)				
No. of students		274 (11)	216 (9)	156 (6)
Single-grade	Multigrade			
Grade 3	Grade 3-4	74 (3)	88 (4)	78 (3)
Grade 4		84 (3)		
Grade 5	Grade 5-6	66 (3)	128 (5)	78 (3)
Grade 6		50 (2)		
Av. classroom size (min-max)		25 (19-32)	26 (18-30)	26 (22-29)
Av. proportion boys (min-max)		.48 (.32-.60)	.52 (.39-.70)	.51 (.42-.61)
Age in months (median, min-max)				
Single-grade	Multigrade			
Av. grade 3	Grade 3-4	104 (94-120)	110 (93-135)	108 (95-124)
Av. grade 4		117 (104-131)		
Av. grade 5	Grade 5-6	129 (119-145)	135 (114-156)	134 (119-153)
Av. grade 6		140 (132-156)		
Network density (min-max)[a]				
Av. ties		21 (5-39)	21 (11-38)	12 (5-24)
Av. degree		0.9 (0.2-2.0)	0.9 (0.4-1.7)	0.5 (0.2-1.1)
Av. density		.04 (.01-.10)	.04 (.01-.09)	.02 (.01-.05)
Network density for gender (min-max)[b]				
Av. density boy-boy		.06 (.01-.11)	.06 (.01-.13)	.03 (.01-.08)
Av. density boy-girl		.01 (.00-.07)	.02 (.00-.08)	.01 (.00-.02)
Av. density girl-girl		.02 (.00-.14)	.02 (.00-.05)	.01 (.00-.03)
Av. density girl-boy		.07 (.00-.27)	.05 (.01-.16)	.04 (.01-.11)
Network density for grade (min-max)[b]				
Av. density low-low		--	.04 (.00-.12)	.03 (.00-.09)
Av. density low-high		--	.03 (.00-.07)	.02 (.00-.05)
Av. density high-high		--	.06 (.01-.10)	.02 (.00-.06)
Av. density high-low		--	.04 (.00-.11)	.02 (.00-.03)

Notes. [a]Density is the proportion of observed ties present in the network in relation to the total amount of possible ties available in the network. [b]Density for gender or grade is based on the proportion of ties present in each group in relation to the total amount of possible ties available in each group.

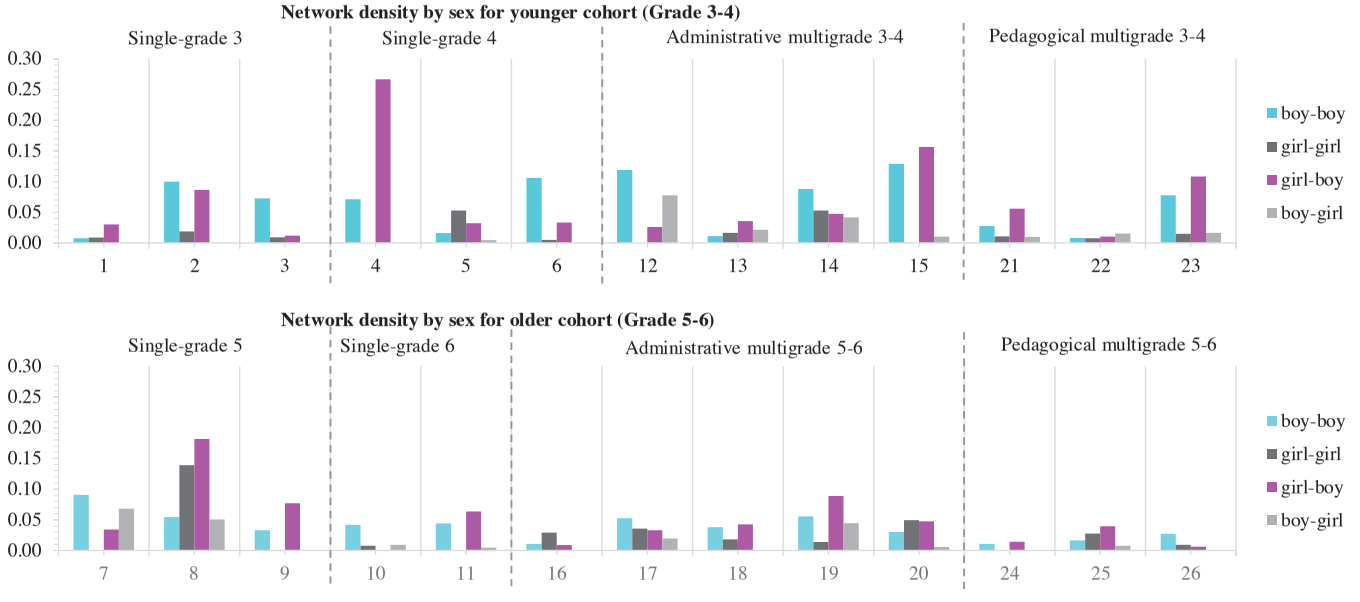


Figure 2.2 Distribution of classroom network density based on victimization by boys and girls, sorted by classroom type (regular single-grade: 1-11; administrative multigrade: 12-20; pedagogical multigrade: 21-26). Figure above shows the densities per classroom for the younger cohort group (grade 3-4 = 1-6, 12-15, 21-23), Figure below shows the densities for the older cohort group (grade 5-6 = 7-11, 16-20, 24-26).

Notes. The density for each group was calculated as the number of observed ties in each group divided by the total number of possible ties in each group. Density was calculated in Ucinet 6 version 6.459 (Borgatti et al., 2002).

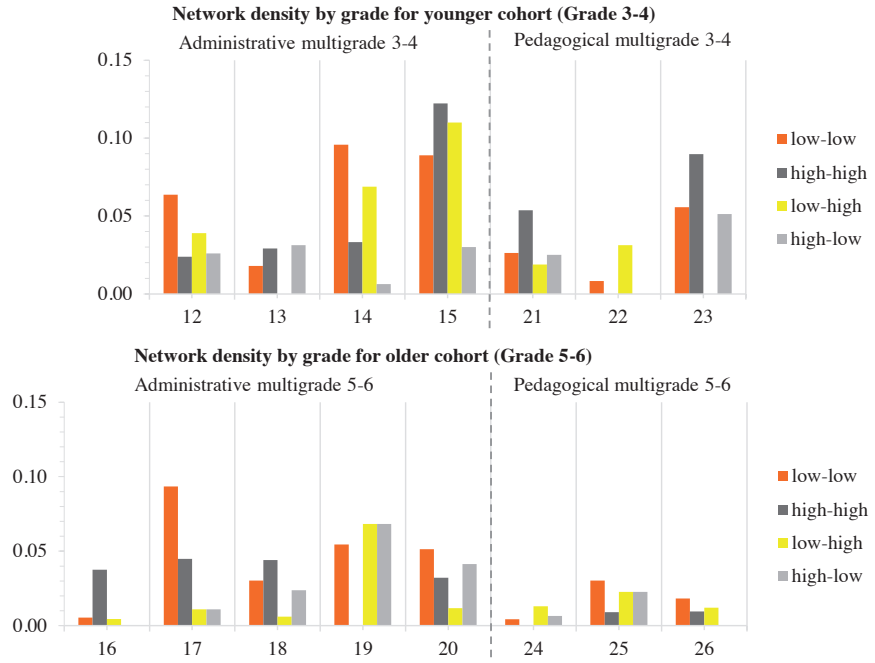


Figure 2.3 Distribution of classroom network density based on victimization by higher-grade students and lower-grade students, sorted by classroom type (administrative multigrade: 12-20; pedagogical multigrade: 21-26). The top figure shows the densities per classroom for the younger cohort group (grade 3-4 = 12-15, 21-23), The bottom figure shows the densities for the older cohort group (grade 5-6 = 16-20, 24-26).

Notes. The density for each group was calculated as the number of observed ties in each group divided by the total number of possible ties in each group. Density was calculated in Ucinet 6 version 6.459 (Borgatti et al., 2002).

2.6.2 Kruskall-Wallis test

The Kruskal-Wallis test shows no statistically significant differences in the median scores of tie percentage at the classroom level (average in-degrees) between the three classroom types (single-grade, administrative multigrade and pedagogical multigrade). This means that there is no evidence that the three classroom types differ in victimization (χ^2 (2, n = 26) = 4.5, p = .11), with a median rank of 14 for single-grade classrooms, 17 for administrative multigrade classrooms, and 5.8 for pedagogical multigrade classrooms.

2.6.3 ERGM findings

Figure S2.2 in the Supplements shows the results per classroom with forest plots (Viechtbauer, 2010). We use them to identify potential outliers. Visual inspection reveals two potentially influential cases. Single-grade classroom 9 is clearly an outlier, with a positive density (Figure 2.5). This is because every boy in class was nominated as bully and boy-boy is the reference

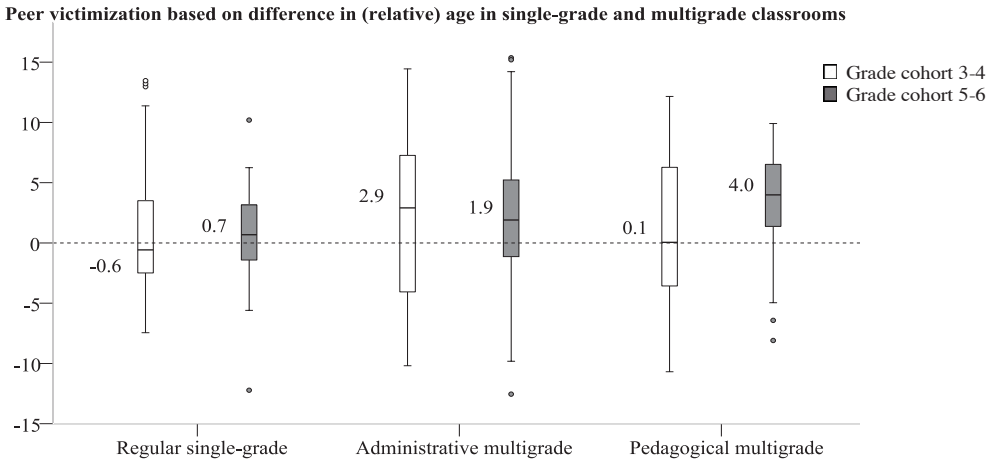


Figure 2.4 Summarized distribution of age-based victimization separated by grade cohort (grade 3-4, grade 5-6) and classroom type (regular single-grade, administrative multigrade, pedagogical multigrade).

Notes. The figure shows the summarized differences in age (*a*) between victims' bullies (*j*) and victims' non-bullies (*j'*), calculated as: $\sum_j a_{bj'} - \sum_j a_{bj}$,and separated by grade cohort. The dashed line in the middle represents the mean age in classroom. The part of the bar *above* the dashed line represents the children who are being victimized by older children in classroom, whereas the part *below* the dashed line represents the children who are being victimized by younger children in classroom. This figure was created using SPSS 22 (IBM Corp).

category. In addition, administrative multigrade classroom 17 is also suspicious with a very negative high-low effect (see Figure 2.5). Additional analysis (using build-in diagnostics in metafor; Viechtbauer & Cheung, 2010) showed that these two classrooms were indeed outliers. We discuss our findings leaving out two classrooms that were identified as outliers. Removing these classrooms from the meta-analysis, led to more reliable results (referring to less variation across classrooms and results were not more "favorable"; compare Table 2.4 with Table 2.5).

Table 2.5 presents the summary of the ERGMs without the two outliers. The first column in Table 2.5 shows the mean estimates across administrative multigrade classrooms (as reference), the two other columns show the degree to which regular single-grade and pedagogical multigrade classrooms deviate from this.

Network effects

The results of the basic network effects were comparable across the three classroom types (see Table 2.5). Taking the degree of victimization among boys into account (referring to proportion of bully nominations given), the negative *density* effects across all three classroom types indicate the low occurrence of victim-bully relationships. The positive *isolates* effects

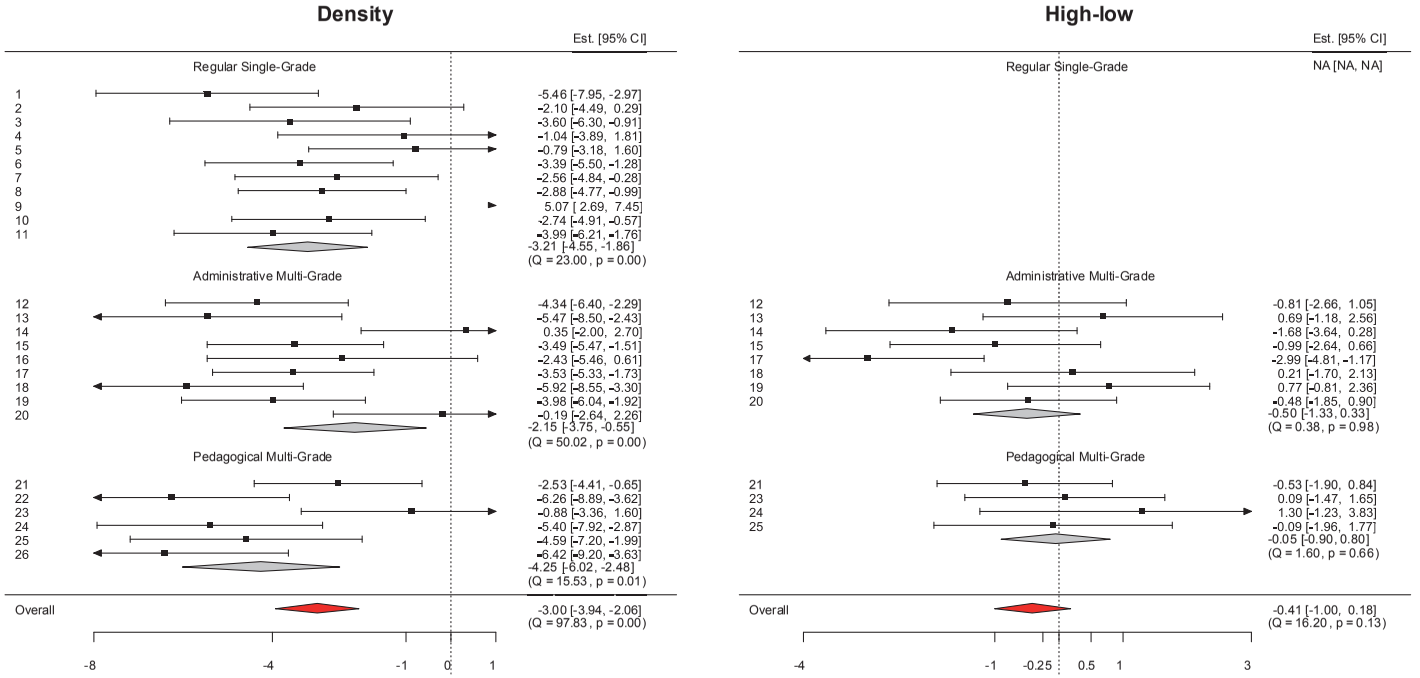


Figure 2.5 Forest plots of estimates of density (left) and high-low (right) effects.

indicate that some students were uninvolved in victim-bully relationships: they were neither victimized nor bullied others. The positive *sinks* effects show that some students, while nominating none as a bully themselves, were considered as bully by classmates. The *in-ties spread* effects and *shared-in-ties* effects, reveal that there is no clear pattern in the occurrence of variability in receiving and sending bully nominations. Finally, there was no evidence for the occurrence of bully-victims patterns. Taken together, the network effects imply that all three classroom types are comparable in network structure.

Sex effects

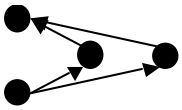
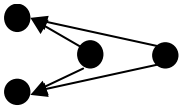
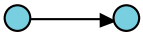
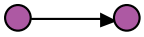
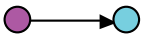
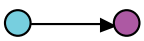
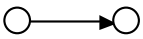
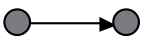
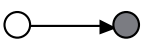
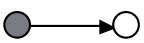
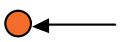
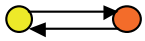
Taking into account all other effects, the ERGMs show on average no clear sex differences in bullying involvement across the three classroom types (see Table 2.5). Subtle (non-significant) differences in the mean estimates were observed for the *girl-boy* effects (more positive in single-grade classrooms and pedagogical multigrade classrooms) and *girl-girl* effect (more negative in single-grade classrooms and pedagogical multigrade classrooms). Overall, the results suggest higher involvement as bully in boys than girls in both single-grade classrooms and pedagogical multigrade classrooms than in administrative multigrade classrooms.

Age and grade effects

Social network analyses showed no evidence that victimization depends on age differences between children in any of the three classroom types: on average, older children did not receive more bully nominations from younger children than vice versa (non-significant age-difference effects). In addition, there was no evidence that older children received more bully nominations than younger children (non-significant age-receiver effects). We checked whether these non-significant effects were a result of low sensitivity (by using a stricter cut-off point for victimization, referring to being victimized 2 or 3 times a month instead of once or twice; see, Solberg & Olweus, 2003), which was not the case (see Table 2.6). We also tested for sex differences, by including an interaction term for the sex combinations, but found no significant interaction effects (see Table 2.7). Note that age effects were smaller than grade effects in terms of "effect size" even when assessed on a 1-year basis.

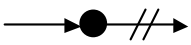
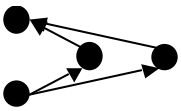
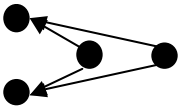
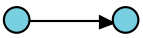
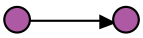
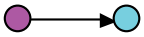
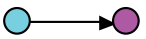
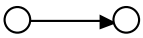
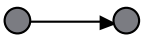
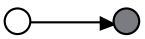
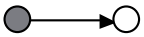
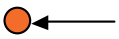
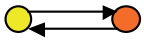
Administrative multigrade classrooms showed a negative *low-high* effect indicating that students in the lower grade were bullied less by students in the higher grade. In contrast, pedagogical multigrade classrooms showed a positive effect. However, this grade dominance effect was driven only by two classrooms (pedagogical multigrade classrooms 22 and 24; see Figure 2.6). These findings indicate that victim-bully relationships in administrative multigrade classrooms occurred mainly among same-grade students, whereas in pedagogical multigrade classrooms they sometimes also occurred across grades.

Table 2.4 ERGM meta-analysis results for victimization networks in single-grade and multigrade classrooms.

Parameter	Illustration	*n*	Intercept (administrative multigrade) Est.	SE	Intercept + regular single-grade Est.	SE	Intercept + pedagogical multigrade Est.	SE
Network effects								
Density (Arc)		26	-3.21**	.80[a]	1.06	1.08[a]	-1.06	1.27[a]
Sinks (sink)		26	1.04*	.18	.18	.62	.32	.74
Isolates (isolates)		26	1.28+	.69[a]	1.30	.95[a]	.07	1.11[a]
In-ties spread (AinS)		23	.73	.56[a]	-1.00	.79[a]	-.14	.96[a]
Multiple two-paths (A2P-T)		20	-.01	.15	-.14	.22	.15	.30
Shared in-ties (A2P-D)		21	.15	.14	-.01	.18	-.04	.28
Sex effects								
Boy-boy (ref.cat.)		26	--	--	--	--	--	--
Girl-girl		19	.02	.38	-.28	.54	-.38	.63
Girl-boy		25	.01	.28	.54	.38	.71	.47
Boy-girl		16	-.43	.35	-.07	.55	-.40	.62
Grade effects								
Low-low (ref.cat.)		15	--	--	--	--	--	--
High-high		12	.14	.30	--	--	.28	.55
Low-high		13	-.61	.42[a]	--	--	1.68*	.71[a]
High-low		12	-.62	.38	--	--	.63	.66
Age effects								
Age-receiver		26	.02	.08	.02	.11	-.02	.15
Difference in (relative) age		26	-.01	.06	.02	.08	.01	.11

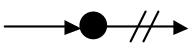
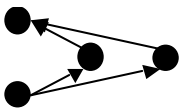
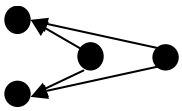
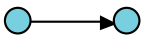
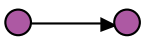
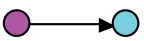
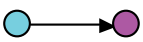
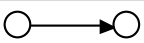
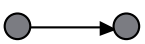
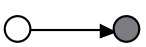
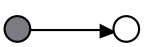
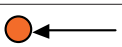
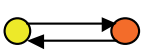
Notes. $+p \leq .10$, $*p \leq .05$, $**p \leq .01$. [a]Significant differences between classrooms. To help interpret the effects in this table, an illustration is provided for each parameter. Victim–bully relationships are represented with directed arrows (referring to targets nominating perpetrators). Students are represented with colored nodes (sex: boys in blue, girls in purple; grade: lower grade students in white, higher grade students in gray; age: older children in orange, younger children in yellow). The parameter statistics of the network effects used in PNet are mentioned in parentheses (short names).

Table 2.5 ERGM meta-analysis results for victimization networks in single-grade and multigrade classrooms – leaving out the two outliers (classroom 9 and 17).

			Intercept (administrative multigrade)		Intercept + regular single-grade		Intercept + pedagogical multigrade	
Parameter	Illustration	*n*	Est.	SE	Est.	SE	Est.	SE
Network effects								
Density (Arc)		24	-3.16**	.66[a]	.28	.89	-1.06	1.02
Sinks (sink)		24	1.31**	.49	-.10	.66	.05	.76
Isolates (isolates)		24	1.51**	.48	.31	.65	-.14	.73
In-ties spread (AinS)		21	.63+	.36	-.14	.51	-.12	.62
Multiple two-paths (A2P-T)		18	-.02	.18	-.06	.24	.17	.32
Shared in-ties (A2P-D)		19	.11	.16	.03	.21	-.003	.29
Sex effects								
Boy-boy (ref.cat.)		24	--	--	--	--	--	--
Girl-girl		18	.16	.41	-.42	.57	-.51	.66
Girl-boy		23	.16	.28	.25	.38	.53	.46
Boy-girl		15	-.27	.38	-.21	.57	-.45	.63
Grade effects								
Low-low (ref.cat.)		13	--	--	--	--	--	--
High-high		11	.32	.31	--	--	.12	.53
Low-high		12	-.36	.38	--	--	1.37*	.63
High-low		11	-.30	.33	--	--	.25	.54
Age effects								
Age-receiver		24	.03	.08	.01	.11	-.02	.15
Difference in (relative) age		24	-.01	.07	.03	.09	.01	.11

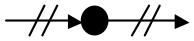
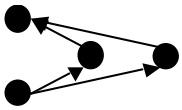
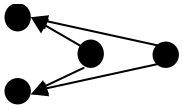
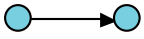
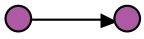
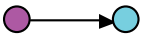
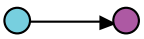
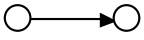
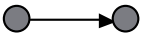
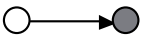
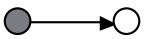
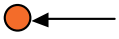
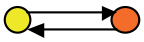
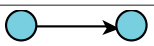
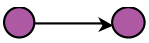
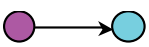
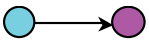
Notes. See Table 2.4.

Table 2.6 ERGM meta-analysis results for lower-bound victimization networks in single-grade and multigrade classrooms.

			Intercept (administrative multigrade)		Intercept + regular single-grade		Intercept + pedagogical multigrade	
Parameter	Illustration	*n*	Est.	SE	Est.	SE	Est.	SE
Network effects								
Density (Arc)		24	-1.82	1.24[a]	-.29	1.71[a]	-2.08	2.08[a]
Sinks (sink)		23	3.23**	.61[a]	-.94	.81[a]	-.55	.98[a]
Isolates (isolates)		22	3.67**	.92[a]	.26	1.23[a]	-.82	1.58[a]
In-ties spread (AinS)		19	-.08	.72[a]	-.69	1.05[a]	-.03	1.25[a]
Multiple two-paths (A2P-T)		15	-.05	.20	-.11	.27	.21	.32
Shared in-ties (A2P-D)		19	-.05	.20	.20	.24	.10	.32
Sex effects								
Boy-boy (ref.cat.)		24	--	--	--	--	--	--
Girl-girl		16	.28	.48	-.58	.66	-1.09	.77
Girl-boy		22	.32	.59[a]	.41	.83[a]	.25	1.05[a]
Boy-girl		16	-.40	.46	-.09	.70	-.53	.76
Grade effects								
Low-low (ref.cat.)		14	--	--	--	--	--	--
High-high		10	.08	.37	--	--	.38	.60
Low-high		12	-1.00*	.45	--	--	1.85*	.76
High-low		10	-.50	.44	--	--	.42	.75
Age effects								
Age-receiver		24	.07	.09	-.02	.12	-.09	.16
Difference in (relative) age		24	.002	.07	.01	.09	-.01	.12

Notes. See Table 2.4.

Table 2.7 ERGM meta-analysis results for victimization networks in single-grade and multigrade classrooms – effects of sex-based age-difference.

			Intercept (administrative multigrade)		Intercept + regular single-grade		Intercept + pedagogical multigrade	
Parameter	Illustration	*n*	Est.	SE	Est.	SE	Est.	SE
Network effects								
Density		25	-3.22**	.78[a]	1.33	1.07[a]	-1.09	1.24[a]
Sinks		25	1.07*	.48	.13	.66	.36	.77
Isolates		25	1.23+	.68[a]	1.52	.95[a]	.13	1.07[a]
In-ties spread		23	.75	.54[a]	-.96	.76[a]	-.11	.93[a]
Multiple two-paths		20	-.02	.16	-.14	.22	.18	.30
Shared in-ties		21	.15	.14	-.01	.18	-.03	.27
Sex effects								
Boy-boy (ref.cat.)		25	--	--	--	--	--	--
Girl-girl		18	.002	.48[a]	-.39	.69[a]	-.45	.78[a]
Girl-boy		24	.24	2.68[a]	.16	3.79[a]	-5.90	4.23[a]
Boy-girl		16	-.74	1.05[a]	-2.10	1.63[a]	-.60	1.77[a]
Grade effects								
Low-low (ref.cat.)		15	--	--	--	--	--	--
High-high		12	.17	.32	--	--	.28	.59
Low-high		13	-.64	.42[a]	--	--	1.75*	.73[a]
High-low		12	-.65	.40	--	--	.69	.69
Age effects								
Age-receiver		25	.03	.08	.02	.12	-.02	.15
Difference in (relative) age		25	-.01	.08	.04	.11	.01	.14
Age effects								
Boy-boy (ref.cat.)		25	--	--	--	--	--	--
Girl-girl		18	-.03	.11	-.005	.18	-.01	.20
Girl-boy		24	.02	.37[a]	-.02	.52[a]	.87	.58[a]
Boy-girl		16	-.06	.12	.0003	.19	.05	.22

Notes. See Table 2.4.

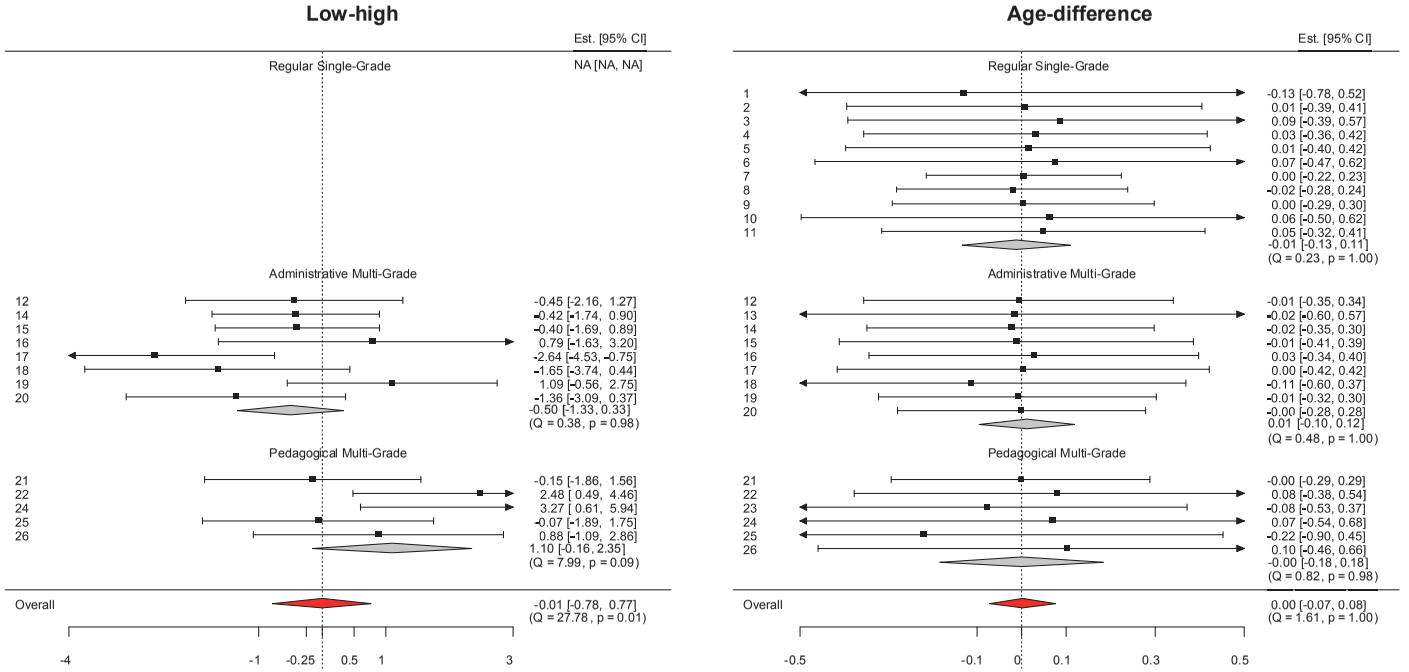


Figure 2.6 Forest plots of estimates of low-high (left) and age-difference (right) effects.

Taken together, there is no conclusive evidence for the idea that victimization depends on (relative) age differences or grade differences between children in classrooms.

2.7 Discussion

We aimed to address the question whether age-differences between classmates can serve as indicators for power imbalance in bullying by examining whether single-grade and multigrade classrooms differ in victimization and whether victimization depends on (relative) age or grade differences between children. Drawing on a status framework, in multigrade classrooms we expected to find higher victimization, especially for younger children targeted by older children. The competing hypotheses, derived from an evolutionary model, would suggest otherwise. Victimization was treated as a relationship between victim and bully, and therefore analyzed with social network analysis. Our analyses showed no evidence that single-grade and multigrade classrooms differ in degrees of victimization nor a systematic indication that victimization is based on (relative) age or grade differences. Thus, providing no support for either the status-framework or the evolutionary model.

The analysis showed instead that victimization in administrative multigrade classrooms occurs mostly within the same grade, and thus between children whose age differences are relatively small. An explanation is that it is relatively easy for older children to bully younger children and therefore bullying someone younger as themselves does not enhance their status. Peers might be more inclined to award bullies with status when bullies challenge others of equal (or higher) status in the group. Likewise, younger children in the multigrade classroom are probably not in a strong position to take on older bullies, and therefore seek out others within their own respective lower grade. This could also explain why we found bullying among same-age or same-grade peers in administrative multigrade classrooms. Another explanation is that teachers in administrative multigrade classrooms generally teach the grades separately (Mulryan-Kyne, 2007; Veenman, 1995), and this decreases opportunities for bullying between cross-age or cross-grade classmates.

The evolutionary model may be relevant for pedagogical multigrade classrooms. We observed differences in degrees of victimization between the two types of multigrade classrooms: lower degrees of victimization in pedagogical multigrade classrooms compared to administrative multigrade classrooms.

Findings also revealed no clear sex differences in bullying involvement across the three classroom types, after controlling for network structure, and age/grade. This is surprising given evidence on the differences between girls' and boys' friendship networks during the

middle to late childhood developmental period (see Rose & Rudolph, 2006), with important differences found in playmate selection, friendship formation (Maccoby, 1998), and social hierarchy development for boys and girls.

It could be that age (and additionally grade in multigrade classrooms) and sex was not sufficient to investigate the effects of power imbalance in classrooms. For instance, it may be that among the youngest kids only those who are physically smaller and weaker become targets of victimization by classmates. Hence, physical appearance or physical strength may explain differences in children's social positions rather than their age (or grade). In support of this argument, recent research has shown that victimization is higher among boys who are pubertal underdeveloped or those who misperceive themselves to be underweight (Haltigan & Vaillancourt, 2018; Lee, Dale, Guy, & Wolke, 2018). Within the context of bullying another important indicator of power (imbalance) to control or harm others is peer perceived popularity (Salmivalli, 2010), or more broadly defined status differences, for instance in the form of SES (Chaux & Castellanos, 2015), majority/minority status or LGBT status (Juvonen & Graham, 2014). Clearly, more precision is necessary for the measurement of power imbalance to understand how power imbalance unfolds in victim-bully relationships.

2.7.1 Implications of the research

Our findings may have implications for school policy about classroom organization. When transitioning to a multigrade classroom organization, parents worry about their child's progress and well-being. Previous research points in the direction that children in administrative multigrade classrooms are not better or worse off in terms of socio-cognitive outcomes (e.g., academic achievement and social adjustment). In this study, we extend previous research by showing that there is also no clear indication that multigrade classrooms increase the risk of victimization by classmates compared to single-grade classrooms.

Our findings indicate that multigrade classrooms may be beneficial for victimization when they are part of the school's educational philosophy. This finding is also in line with broader theory and research on the positive effects of pedagogical multigrade classrooms (e.g., in Jenaplan or Montessori schools, see Lillard & Else-Quest, 2006; Moller et al., 2008), which stimulate prosocial behavior among children by encouraging the provision of help across the grades within the classroom (Lillard & Else-Quest, 2006; Gray, 2011). Although based on a few classrooms, it suggests that schools that encourage prosocial relationships among children by encouraging the provision of help across grades within the same classroom (Lillard & Else-Quest, 2006; Gray, 2011), may have less bullying between classmates. A recent study also shows that schools engaged in practices to promote inclusiveness and equity

as a social-learning program may foster openness and acceptance of others (Rivas-Drake, Saleem, Schaefer, Medina, & Jagers, 2019). An avenue for further research could be to examine the extent to which single-grade and (administrative and pedagogical) multigrade classrooms operate similarly or differently for positive peer relationships, such as prosocial or helping relationships in the classroom.

2.7.2 Strengths, limitations, and directions for future research

An important strength of this study is that we investigated the role of (relative) age and grade differences between classmates in victim-bully relationships. Assessing these associations in a sample of single-grade and multigrade classrooms further add to our understanding of classroom differences in elementary education. By applying social network analysis we do not violate the assumption of independence of observations within classrooms.

To allow for a comparison between different classrooms, our sample is relatively small because we had to exclude many schools with multigrade classrooms with a different grade combination (referring to more than two grades in the same classroom). It is possible that our null-findings are due to low statistical power (related to the low number of classrooms that were included). Future research should validate these findings using a larger sample, preferably with larger within-classroom grade differences.

It should also be pointed out that schools that have different grades within the same classroom as a consequence of grade/classroom mixing tend to be unstable in terms of student classroom composition over school years. Hence, an obvious next question is how this grade/classroom mixing affects children in terms of bullying and peer victimization (Rambaran, van Duijn, Dijkstra, & Veenstra, 2019a).

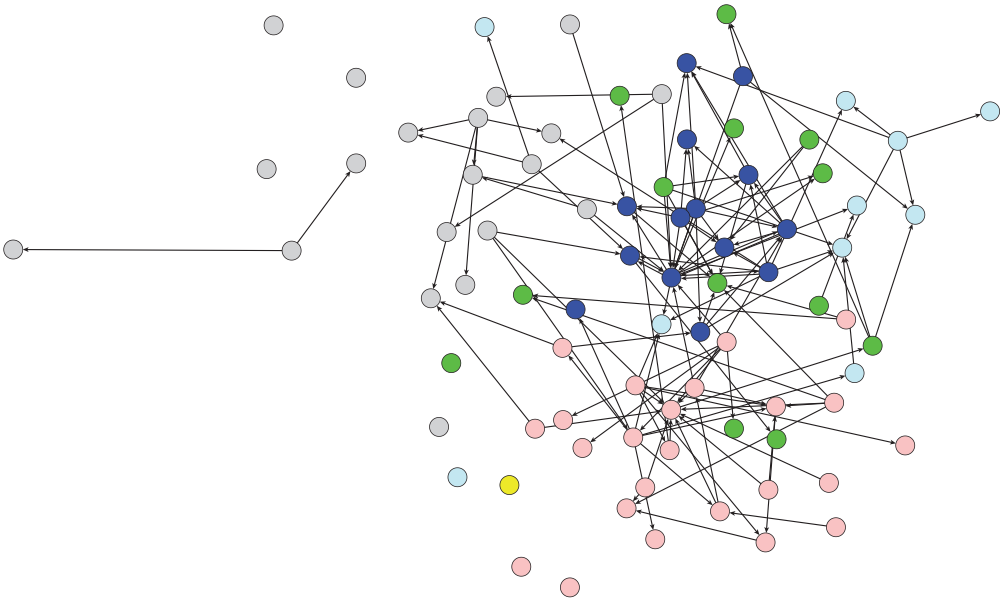
We did not measure victimization by peers outside the classroom because the focus in this study was on the classroom. However, part of the victimization might occur by other peers in school or outside of school. We only measured peer victimization by asking the students "Who starts bullying you?" We had good reason for this because students who initiate the bullying are often considered as "ringleader" bullies (Salmivalli, 2010), and, thus, they may be more powerful and influential than followers who join in the bullying.

2.7.3 Conclusion

In sum, our findings did not provide evidence that (relative) age differences or grade differences play a role in victimization in multigrade classrooms compared to single-grade classrooms. Apparently, processes of power imbalance in bullying are not (or only weakly) related to students' (relative) age differences or grade differences within the same classroom.

Chapter 3

Stability and Change in Student Classroom Composition and its Impact on Peer Victimization



This chapter is based upon:

Rambaran, J.A., van Duijn, M.A.J., Dijkstra, J.K., & Veenstra, R. (2019). Stability and Change in Student Classroom Composition and its Impact on Peer Victimization. *Journal of Educational Psychology,* accepted for publication.

Although peer victimization in school mainly takes place between children in the same classroom or grade and bullying is generally seen as a group process, little is known about how stability and change in classroom composition affect peer victimization. Hence, this study addressed the following questions: (1) Are newcomers in the classroom more likely to become victims? (2) Does a stable classroom, where children generally have the same classmates over time, lead to less change in bully nominations? To address these questions, this paper examined three waves of bully nominations in a sample of 3,254 children (50% boys; age 8-12) in 31 elementary schools, displaying three types of schools: stable or unstable administrative or pedagogical multigrade. Both research questions were answered by longitudinal social network analyses of the school-wide networks. The meta-analyzed results of these analyses with small effect sizes showed that (1) although stable classrooms do not necessarily show less change in bully nominations than in unstable classrooms, victim-bully ties are more likely to develop among students in the same grade or same classroom and (2) newcomers were more likely to become victims, more so in unstable schools than in stable schools.

Keywords: social networks; peer victimization; student classroom composition; stability and change; childhood

3.1 Introduction

Peer victimization is widespread in elementary schools across the world. Although prevalence of peer victimization at school varies between countries, figures from nationally representative samples in Europe and North America show that on average 30% of children are occasionally victimized by schoolmates and 10% are chronic victims (Chester et al., 2015). The long-term effects of peer victimization can be devastating for victims of school bullying, including poor academic functioning, anxiety, depression, and future delinquent and aggressive behavior (Ladd, Ettekal, & Kochenderfer-Ladd, 2017; McDougall & Vaillancourt, 2015; Wolke & Lereya, 2015). Prevention efforts to stop bullying behavior has been at best moderate, making it an ongoing concern for schools, teachers, and parents (for a review: Rivara & Le Menestrel, 2016). It is therefore important to understand when and under what conditions bullying emerges and persists.

Peer victimization is largely studied as phenomenon that takes place between classmates (Salmivalli, 2010). Yet, little is known about how the school or classroom context affects peer victimization (Juvonen & Graham, 2014). A contextual factor to consider is stability of the classroom composition across the school years. It is reasonable to expect that classroom composition changes are likely to impact the interactions between children because it minimizes their opportunities to connect with each other (Valente, 2012).

Using individual-level bullying measures, previous research found lower self-reports of bullying and victimization among students who moved to a different location during the transition to middle school compared to students who stayed in the same school (Farmer et al., 2011a; Wang et al., 2016). An explanation is that such transitions break up the dominance structures and the accompanying bullying. Bullying may also be the reason why children move to a different school. Thus, changing the classroom composition may break up victim-bully relationships and help in reducing bullying.

Researchers increasingly recognize that bullying is relational, and that a relational approach allows for a more nuanced understanding of *who bullies whom* in the classroom (Rodkin et al., 2015; Veenstra et al., 2007). Bullies target specific victims, particularly the classmates with the weakest positions, and victim-bully ties are also subject to change over time (Huitsing et al., 2014; Rambaran, Dijkstra, & Veenstra, 2019b). Classmates generally have a good sense of each other's social positions (Farmer et al., 2011b), and it is reasonable to assume that this is greater in a stable classroom (Farmer et al., 2011a). In addition to established classroom members with weak positions, newcomers may also suffer from an initially weak social status when transitioning to a new school environment, although still relatively little is known about this group.

We examine the dynamics in victim-bully relationships and focus on individual effects (newcomers) and dyadic effects (number of times a child shared the same classroom with a peer) that capture the complexity of stability and change in classroom composition. To this end, we examine three waves of victim-bully relationships in a sample of elementary schools in middle to late childhood that differ in the extent to which students are organized in same or different classrooms over time, using longitudinal social network analysis.

3.2 Theory

3.2.1 Positions in peer groups in middle and late childhood

Middle and late childhood is an important developmental period in which children develop social skills that help them establish positive peer relationships. During this period, children become more aware of their own and other's position in the peer group (Kolbert & Crothers, 2003). Within the school context, peer groups are largely formed within the classroom as children spend most of their school time there. The way children behave and interact with each other plays an important role in how positions and roles are defined (Farmer et al., 2011b). During the middle and late childhood period, children differentiate peers who are prosocial (referring to being nice and cooperative), from peers who are coercive (referring to being harmful and aggressive), to obtain social positions in the group based on social status and acceptance from peers (Hawley, 1999). Both behaviors form the basis for youth in defining positions and roles in the classroom. For instance, children who are generally prosocial may receive more friendships and likes, which makes others perceive them as social leaders among peers. However, children differ in their abilities to be prosocial, and, some may turn to coercive (aggressive) strategies to obtain dominant positions among peers, most likely by bullying others in the group. Bullies are considered to be socially skilled children that use proactive aggressive strategies to obtain dominance and social status among peers (Sijtsema, Veenstra, Lindenberg, & Salmivalli, 2009). In doing so, bullies tend to enhance their position in the peer group by targeting weaker peers (Rodkin et al., 2015; Salmivalli, 2010; Veenstra et al., 2010). Moreover, bullies often seek social support from peers that help them to maintain a high position, by becoming friends with others who join their bullying (Rambaran et al., 2019b) and by receiving help against defenders of victims (Huitsing et al., 2014). Once positions are formed, children may settle with their group position, as bully, victim or uninvolved. However, children's positions and roles in the classroom are not necessarily stable and it is reasonable to assume that this depends on changes in the classroom composition.

3.2.2 Classroom composition changes and victim-bully networks

Changes in the classroom composition and its impact on peer victimization may take different forms. To clarify this, it is important to consider school networks as nested structures with individual students nested in classrooms in schools. Of further importance is that peer victimization is nested in dyads as it describes a relationship between two students (e.g., student *i* nominates another student *j* as his or her bully). Figure 3.1 provides an illustration of a school-wide victim-bully network with transitions across three school years. The network consists of 93 students clustered in five classrooms in Year 1 (T1) and Year 2 (T3), but four classrooms in Year 3 (T5) because the students in one classroom moved on

to secondary education at T5. The students are represented with colored nodes, where each color represents a different classroom. Their victim-bully ties to each other are represented with directed arrows. Three of the five classrooms at T1 (Grade 2, 3, and 5) remained relatively stable over time (the students remained in the same class together over the school years). Two other classrooms with the same grade (Grade 5A and Grade 5B) were "mixed" at T3. In addition to changes at the classroom (or school) level (referring to classroom mixing), there are changes at the individual level. For instance, one student joins the classroom (network) at T3, whereas 17 students leave the (school) network (at either T3 or T5). As shown in Figure 3.1, most victim-bully ties are clustered within classroom or grade, and the number of victim-bully ties gradually decreases over time.

To capture the above-described complexities and changes within a school victim-bully network, we examine the individual effect of being a *newcomer*, referring to students who enter a rather stable classroom, and the dyadic effect of *same classroom before*, referring to the number of times a student shared the same classroom with a peer. The *same classroom now* effect refers to students being in the same classroom only once; whereas the *same grade* effect refers to children being grademates. Together, these effects capture how changes in classroom composition affect changes in victim-bully relationships. This is done by including "regular" schools where children typically move classrooms in a following school year with most of their classmates from a previous year. In our study, these schools are referred to as *stable schools* as compared to other schools that (consistently) combine classrooms or grades, which are referred to as *unstable schools*. In addition, we take into account the multigrade classrooms based on administrative and pedagogical reasons. The distinction between the two types of classrooms is important as the motivation for having multigrade classrooms may affect the relation between change in classroom composition and peer victimization due to school climate (Rambaran, van Duijn, Dijkstra, & Veenstra, 2019d).

Individual changes

The student population of classrooms change due to children who repeat a grade, skip a grade, or move houses. In addition, children may have to move to another school, because of low academic achievement, behavioral problems, special learning needs, or parents' request (OECD, 2013). These individual changes affect the amount of change in classroom composition and ultimately children's positions in the classroom. Children who are new in a classroom may experience more difficulties with social adjustment than established classroom members (Geven, Weesie, & van Tubergen, 2016; Lubbers, Snijders, & van der Werf, 2011). In a stable classroom, children generally know each other, as they have a shared history. Newcomers might experience more difficulties to integrate within the group and

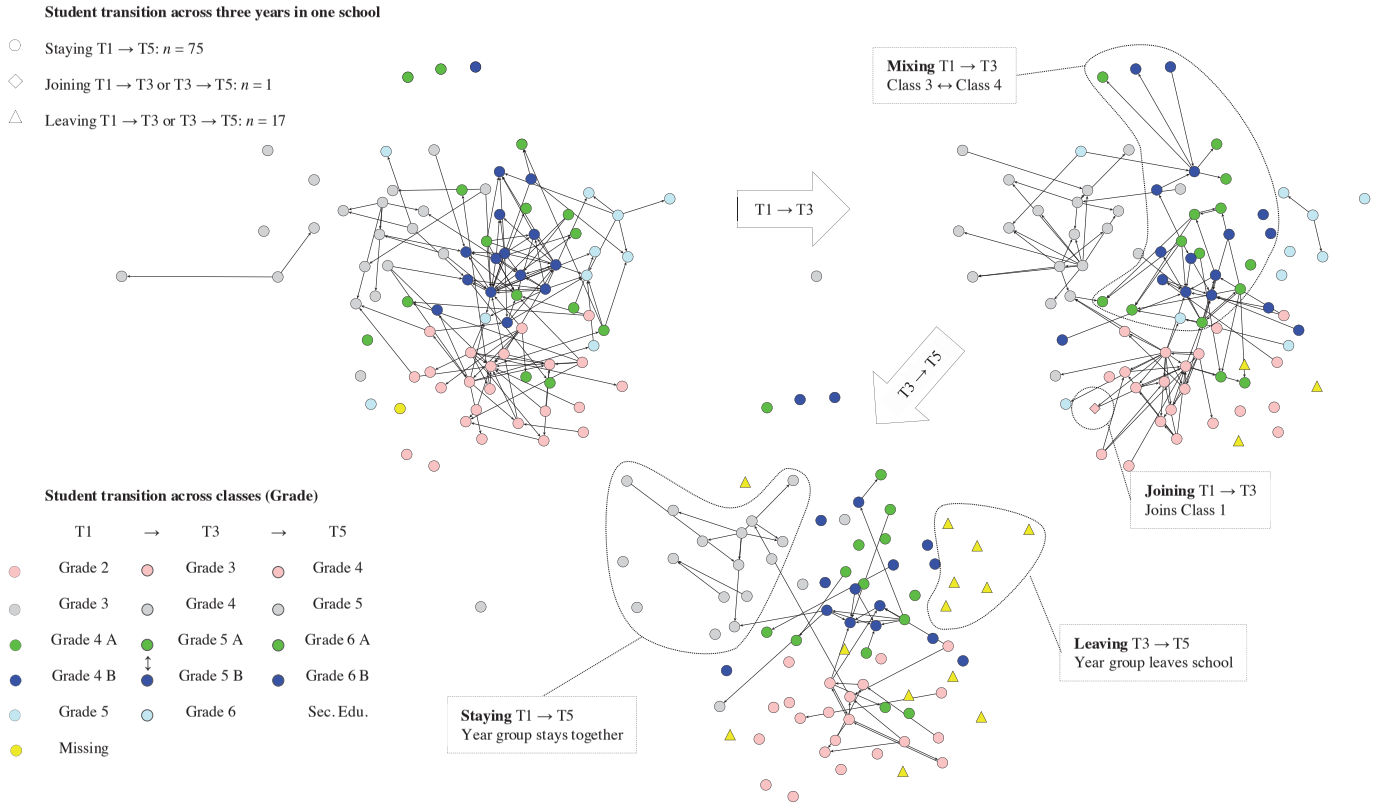


Figure 3.1 Transition of students (nodes) and their victim-bully ties (arrows) in classes in a stable (single-grade) school (n* = 93 students) with two parallel groups that are mixed at T3. *For practical reasons (ease of interpretation), we removed eight isolates from the networks (students who were uninvolved in victim-bully ties from T1 to T5). Sec. Edu. = Secondary Education. This figure was created in visone (Brandes & Wagner, 2014)

establish friendships. Therefore, we expected that in stable classrooms, newcomers are more likely to become targets for peer victimization (H1).

Classroom changes

In a stable classroom context children know about each other's positions, including whom to target (Farmer et al., 2011a, 2011b). This implies that, in such a context, once children have a weak position they cannot easily change that (Evans & Eder, 1993). In this situation, victims do not have a chance for a "fresh start" and cannot easily escape their bullies and remain socially isolated. Hence, a stable classroom group is likely to lead to persistent peer victimization. Stability in the classroom context may contribute to ongoing bullying of the same targets (Farmer et al., 2011a; Wang et al., 2016). In an early study, it was found that the stability of bullying behavior was weaker in low-stability classrooms (Salmivalli et al., 1998). More recent empirical findings point in the direction that higher group stability results in higher bullying (Farmer et al., 2011a; Wang et al., 2016). Yet, it remains unclear who the victims are because previous research focused on general bullying behavior.

In contrast to stable schools, some other (typically smaller) schools (yearly) combine classrooms or grades for practical reasons, for example, to deal with low enrollment and uneven classroom sizes (Veenman, 1995; Mulryan-Kyne, 2007). Classroom "mixing" greatly affects the amount of stability and change in classroom composition. Entering a new classroom context offers opportunities to re-establish group positions and hierarchies through bullying (Farmer et al., 2011b). Bullying research on the effects of changing peer groups generally focused on the transition to middle or (junior) high school (Farmer et al., 2011b; Pellegrini & Bartini, 2000; Pellegrini & Long, 2002; Wang et al., 2016). School transitions are a risk period for peer victimization because existing peer groups are reshuffled and new social structures are established that are linked to bullying, as children compete over status through bullying in a new social environment (Farmer et al., 2011a, 2011b; Pellegrini, 2002; Pelligrini & Bartini, 2000; Pelligrini and Long, 2002). Reshuffling of peer groups or classrooms results in loss of existing friendships (Neckerman, 1996), which may lead to adjustment problems for victims (Hodges, Boivin, Vitaro, & Bukowski, 1999), as in a new classroom environment victims may find it difficult to find new friends. At the same time, it may also provide an opportunity to escape from their previous bullies. This is probably a reason why children reported less bullying and victimization if they changed classrooms (Farmer et al., 2011a; Wang et al., 2016). Following this line of reasoning, we expected that, in stable schools as compared to unstable schools, victim-bully relationships are more likely to be formed among children who are in the same classroom over multiple school years (H2).

In a stable school context, same classroom typically refers to same grade (referring to same classmates within the same grade). However, same-grade victim-bully relationships may occur also outside the own classroom when there are multiple classrooms of the same grade in the same school (see e.g., the two grade 4 classes 4A and 4B at time 1 in Figure 3.1). In this perspective, same grade may already capture a large proportion of the victim-bully ties between the children who were classmates before. Hence, the two can be seen as complementary to each other. Accordingly, we expected that victim-bully relationships are more likely to be formed among children who are in the same grade, particularly in stable schools compared to unstable schools (H3).

Also in stable schools, changes occur in classroom composition when individual children leave or join the classroom, and we expected that victim-bully relationships are formed among children who are together in the same classroom, even when it is only for one school year, rather than among children in different classrooms (H4).

In addition, research points in the direction that in a stable school environment, higher-grade students in school seek out lower-grade victims because they form an easy target (Huitsing et al., 2014). In view of this power imbalance, we expected lower-grade students to be victimized by higher-grade students (H5).

School climate

The hypothesized effects described above (individual newcomer, and dyadic same classroom before, same classroom now, and same grade) may vary between school types due to school climate. The evolutionary model of risky child/adolescent behavior (Ellis et al., 2012) posits that mixed-age settings, rather than age-segregated school and peer environments, are the natural context for child development. The presence of both older and younger children in mixed-age settings provides a natural hierarchy based on age. In this context, both older and younger children settle more easily with their position in the social group, which decreases the tendency to compete for dominance and status. Evolutionary psychologists argue that older children can serve as positive role models, and that the positive association between status and prosocial behavior reduces the need to gain status through antisocial means. When older children are assigned to younger children as caregivers, buddies, or playmates, they tend to behave less aggressive and more prosocial toward younger children and same-age peers in other contexts as well (Gray, 2011). Thus, the presence of younger children in mixed-age settings reduces aggression and promotes nurturance and compassion in children (Gray, 2011). In contrast, age-segregated schools and peer environments, such as stable schools (with single-grades), have been argued to evoke aggression and conflict in children, and, in such a stable classroom context, children

may actively search for dominance (Ellis et al., 2012).

We distinguish unstable schools with administrative multigrade (mixed-age) classrooms from schools with pedagogical multigrade classrooms because the latter aims to stimulate prosocial relations among children by encouraging the provision of help across grades within the same classroom (Lillard & Else-Quest, 2006; Gray, 2011), whereas schools with administrative multigrade classrooms do not have such an explicit goal (Mulryan-Kyne, 2007; Veenman, 1995). By contrast, teachers in administrative multigrade classrooms were generally found to teach the grades separately (Mulryan-Kyne, 2007; Veenman, 1995), which decreases opportunities for prosocial behavior between older and younger children as such multigrade classrooms emphasize individualized work and do not necessarily encourage interactions between children from different grades (Juvonen, 2018). Schools with pedagogical multigrade classrooms also encourage inclusive behavior, which reduces the probability of (repeated) victims or students who enter a new classroom environment (newcomers) being rejected. The findings of a recent study show that schools engaged in practices to promote inclusiveness and equity as a school program foster positive relationships (Rivas-Drake et al., 2019). Moreover, a positive school climate, for instance through school and student support, community building, and cooperative learning, was shown to reduce the prevalence of peer victimization (Cornell, Shukla, & Konold, 2015; Fink, Pataly, Sharpe, & Wolpert, 2018; van Ryzin & Roseth, 2018). Following this line of reasoning, we expected to find smaller effects (individual, classroom, and grade) in schools that formed multigrade classrooms based on pedagogical reasons compared to stable schools or schools that formed multigrade classrooms based on administrative reasons (H6).

3.3 The present study

We investigate the extent to which stability and change in classroom composition affects the formation of victim-bully relationships among children. We address the following questions: (1) Are newcomers in the classroom more likely to become victims? (2) Does a stable classroom, where children generally have the same classmates over time, lead to less change in bully nominations? To address our research questions, we used a large data set from the Netherlands and selected schools that differ in the extent to which students are organized in same or different classrooms across three school years. We defined three types of schools in the available data: 1) schools that generally form single-grades and are relatively stable in terms of classroom composition, and schools that are relatively unstable in terms of classroom composition due to generally forming multigrades either for (2) administrative or (3) pedagogical reasons. Based on information provided by the school

office about the school's educational philosophy, only schools that mentioned to have a specific educational philosophy were considered as multigrade for pedagogical reasons (e.g., Montessori or Jenaplan schools).

We tested our hypotheses by investigating the changes in victim-bully relationships in three measurements of social networks containing students' bully nominations ("By whom are you victimized?"). We analyzed the longitudinal social network data using SIENA (Simulation Investigation for Empirical Network Analysis; Snijders et al., 2010; Steglich, Snijders, & Pearson, 2010). We controlled for sex and grade (age), because it is relevant in victim-bully relationships, with boys being more dominant and aggressive toward girls (Cook, Williams, Guerra, Kim, & Sadek, 2010) and higher-grade (older) students in school may be seeking out lower-grade (younger) victims because they form an easy target (Chaux & Castellanos, 2015; Huitsing et al., 2014).

3.4 Method

3.4.1 Sample

Schools were drawn from the Dutch KiVa study (Huitsing et al., 2019; Kaufman et al., 2018; Rambaran et al., 2019d) in three consecutive years (Spring 2012, 2013, and 2014, corresponding to wave 1, 3, and 5). KiVa is an intervention program, originally developed in Finland (Kärnä et al., 2011, 2013), and aimed to reduce bullying among children from grades 2-5 in elementary education (7-11 years) in the Netherlands. As part of the intervention program, the participating schools (n = 99) were randomly assigned by the Netherlands Bureau for Economic Policy Analysis (CPB) to either the control condition (33 schools) or to the intervention condition (66 schools). The 33 control schools were selected for the analysis to avoid that differences between schools were a result of the intervention (Kaufman et al., 2018; Rambaran et al., 2019d). Two control schools were dropped: one school did not participate after wave 4, and in another school, 35 of the children participating in wave 1 (12.5%) transitioned from a control school to an intervention school, which made the school a special case and unfit for comparison.

The 31 remaining schools, with 3,254 students (school size varies between 36 and 276) over the three years, were categorized as stable (n = 8; 1,203 students), unstable administrative multigrade (n = 18; 1,436 students), and unstable pedagogical multigrade (n = 5; 615 students). Of all students, 49.9% were boys, the average age of the sample at T1 was 9.6 years (SD = 1.4), 76.1% of students were native Dutch, 18.5% were non-Dutch (minority), and for 7.3% information about their parent's ethnic background was missing.

Of the 2,607 Grade 2-5 students who were targeted to participate in the KiVa control sample in T1 (the "eligible participants"), 2,562 students (98.3%) participated at T1 (Grade 2-5 in May 2012), 2,415 (92.6%) at T3 (Grade 3-6 in May 2013), and 1,734 (66.5%) at T5 (Grade 3-6 in May 2014). The significant drop in participation rate at T5 is because Grade 6 students at T3 continued their educational career in secondary education. The difference between the total sample size of 3,254 students and the number of "eligible participants" at T1 is explained by classroom composition changes (students who joined the school at later time points), and inclusion of students (mainly students who were in Grades 1 or 6 at T1) who did not participate themselves but could be nominated (as bully) by peers.

On each measurement occasion, in an instructional movie, a professional actress explained to students what bullying means, using the following text: "Bullying is when some children repeatedly harass another child. The child who gets bullied has problems defending itself against this. Bullying is not the same as having a fight between two people who are equally strong. Bullying should also not be confused with joking around. Bullying is treating someone repeatedly in a mean way." Several examples of bullying were given to students, including physical and material forms (e.g., hitting someone, kicking or pinching; stealing or damaging someone's belongings) and relational and verbal forms (e.g., making fun of someone, calling names, saying mean things; gossip about someone; excluding from social activities).

3.4.2 Procedure

Students filled in an Internet-based questionnaire in their classroom during regular school hours. The process was administered by the teachers, who were present to answer questions and to assist the students when needed. Prior to the data collection, teachers were given detailed instructions concerning the procedure. During the data collection, support was available through phone and e-mail.

At the beginning of the questionnaire, students received information about the goal of the study, and how to fill in the questionnaire. They were told not to talk to each other or to discuss their answers when they filled out the questionnaire or afterwards to ensure each other's privacy. It was explained to students that their answers would remain confidential. The teachers ensured that students who could not complete the questionnaire at the day of the data collection participated at another day within a month.

Prior to the first measurement (and for students who were new in school, after the first measurement), schools sent information letters to students' parents. A passive consent procedure allowed students or parents to opt out of student participation. At the start of

data collection (2012), universities in the Netherlands did not require IRB permission for this type of research. All procedures performed in this study were in accordance with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. A few students did not want to participate; also a few parents objected to their child's participation. Accordingly, for the first wave participation rate among the "eligible participants" was high (98.3%).

3.4.3 Measures

Dependent variable

Peer victimization was measured with network nominations for bullying following a two-stage procedure. To identify the victims for the second stage (the nomination procedure, detailed below), all participating students were first asked to indicate how often they were victimized in general in the previous months (T1 and T5: "since the Christmas break"; T3: "since the summer break"), according to Olweus' (1996) self-reported bully/victim items, and, to indicate this for specific forms of victimization; physical harm (e.g., kicked), verbal harm (e.g., name calling), relational harm (e.g., gossiping), and cyber victimization. Answers were given on a five point scale: (1) "Not at all", (2) "Once or twice", (3) "Two or three times a month", (4) "Once a week", and (5) "Several times a week."

If participants indicated that they were victimized by classmates at least "Once or twice" (score 2) on any item, they were presented with a roster showing the names of all classmates, and asked whom of their classmates victimized them (referring to "By whom are you victimized?"). In addition, respondents could type in the names of other schoolmates who victimized them by typing in the first letters of their names on the computer screen (a name generator was used). In this nomination procedure, victims nominated their bullies as perceptions and experiences of victims particularly matter. For that reason, we look at bullying from the point of view of the victim. Bullying nominations were measured as present (1) or absent (0). Students who indicated not being victimized by classmates or other schoolmates did not fill out the nomination question. Their "answers" were considered as absent nominations. Based on these nominations, school-wide victim-bully (referring to victim sender and bully receiver) networks were obtained containing all bully nominations in a particular school or classroom (from the victim's perspective). The obtained school-wide victim-bully networks were used in the longitudinal social network analysis.

Explanatory variables

Individual (*newcomers*) and dyadic (*same class before*, *same class now*, and *same grade*) variables were constructed to examine whether and to which extent stability and change

in student classroom composition affects changes in victimization relations.

We determined for students to which extent they were new in school (transferred from another school) or in a classroom (transferred from another classroom in the same school). This was done by calculating the proportion of classmates with which each student remained together in the same classroom across two consecutive school years (referring to between T1 and T3, between T3 and T5). After subtracting the proportion scores from 1, we obtained a continuous covariate that ranged from 0 (students share a classroom with all of their classmates from a previous school year) to 1 (students do not share a classroom with classmates from a previous school year; *newcomers*).

We determined for every pair of students in school how long they had been together in the same classroom, by counting the shared classrooms at T3 (0 or 1) and T5 (0, 1 or 2), labeled as *same class before*.

The two binary dyadic *same class now* and *same grade* variables indicate whether pairs of children are currently (at T3 and T5) in the same classroom or grade.

Control variables
We included *sex* (1 = boy). Students' *grade* was obtained from the school's office.

3.5 Analytic strategy

The stochastic actor-based model implemented in SIENA allows us to examine to which extent changes in victim-bully networks are related to endogenous network effects (e.g., reciprocity) and exogenous individual (newcomers and sex) and dyadic (number of shared classrooms and grade) effects that may explain the changes of ties in these networks.

School network is the unit of analysis. In most schools, student classroom composition changed (see Figure 3.2), particularly in schools that mixed or combined classrooms over time. To facilitate the composition changes in each school, we analyzed each school network including the participants who were present at the first observation moment as well as students who joined or left the networks at the third or fifth observation. In addition, students who were not part of the study design at T1 (the "eligible participants"), but were part of a combination group were also included because they could be nominated as bully by schoolmates, making them part of a school victimization network. This enabled us to make full use of the available information and to analyze the networks according to the

"method of joiners and leavers," which uses information about composition changes in an efficient way (Huisman & Snijders, 2003; Ripley, Snijders, Boda, Vörös, & Preciado, 2019).

Each school network was estimated with the same model specification. In some (larger) school networks, however, additional effects were necessary to achieve acceptable model fit. Ultimately, all models showed good convergence and fit statistics (see for details Table 3.1 and Figure S3.1 in the Supplements), except for three schools (see Table 1; Figure 3.3). Goodness of fit (GoF) was examined using four network statistics: outdegree distribution, indegree distribution, geodesic distance, and triad census, by investigating how well these statistics are captured in a sample of networks simulated according to the estimated model. For each of these statistics, the differences between the values in the observed school network (summed across the three waves of data) and the estimated values (summed across 1,000 simulated networks) are assessed with the Mahalanobis distance (Ripley et al., 2019). Fit for a particular statistic is good or acceptable when the Mahalanobis is small as expressed by a *p*-value larger than .05. The violin plots in Figure S3.1 in the Supplements can be used for a graphical inspection of the departure of the simulated values from the observed value of the statistics (in red). A good network fit is essential to interpret the effects of main interest more reliably.

The effects were first analyzed for each school network separately, and the parameter estimates were then summarized with a meta-analysis using R-package metafor (in a random effects model using the default REML function; Viechtbauer, 2010). Two analyses were performed: one 'simple' model (without covariates) rendering the mean model parameter estimates, obtained in the SIENA analysis per school with the accompanying standard errors as weights as well as a test for between-school heterogeneity, and a model with school type and school size as "explanatory variables" (which can best be understood together, referring to a combination of school type and school size). We controlled for school size because unstable schools are generally smaller compared to stable schools. Thus, to understand the effects of unstable schools school size was taken into account.

3.5.1 Model specification

To adequately capture important features of the victim-bully networks, we followed previous research in choosing the structural parameters in the stochastic actor-based models (Huitsing et al., 2014; Rambaran et al., 2019b). Several structural network effects were included to account for changes in the overall network structure. *Network rate* effects indicate the number of changes in the victim-bully networks. *Out-degree* (density) is included to indicate that students start sending bully nominations to schoolmates (victim

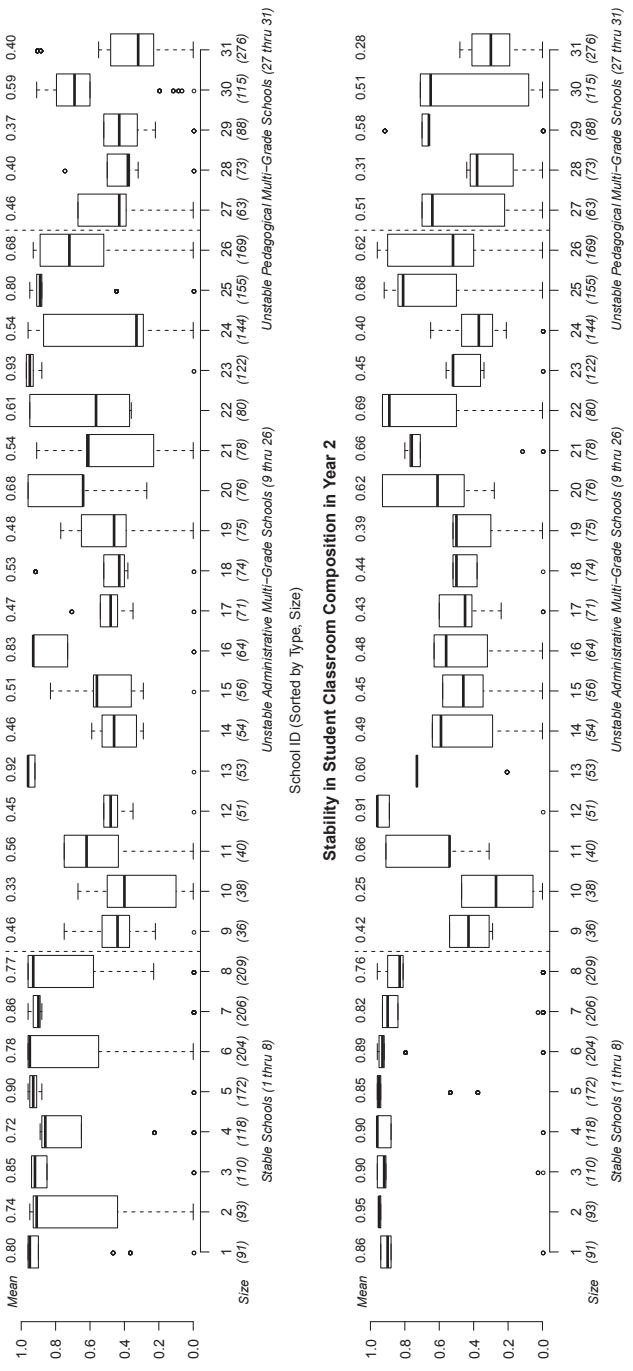


Figure 3.2 Visualization of the stability in student classroom composition per school and year sorted by school type (stable: schools 1 thru 8; unstable administrative multigrade: schools 9 thru 26; and unstable pedagogical multigrade: schools 27 thru 31). The dots in the figure represent newcomers (students who do not share a classroom with classmates from a previous school year). This figure was based on the *newcomer* variable (computed as 1 minus the proportion of newcomers; see Method section 3.4.3 Measures). The mean classroom stability in school is shown above each boxplot (the boxplot itself shows the median). This figure was created in R (R Core Team, 2013).

Table 3.1 Overview of the model effects estimated per school and their corresponding convergence and fit statistics.

Victimization networks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Rate period 1 (t1-t3)																
Rate period 2 (t3-t5)																
Outdegree (density)																
Outdegree at least 1																
Sex alter																
Sex ego																
Same sex																
Newcomer ego																
Grade alter																
Grade ego																
Same grade																
Same class now																
Same class before																
Additional effects[a]																
Outdegree at least 2																
Outdegree at least 2 x time																
Indegree at least 1																
Reciprocity																
Outdegree-activity (sqrt)																
Indegree-popularity (sqrt)																
Indegree-popularity																
Indegree-popularity x time																
Transitive ties																
Indegree-equivalence (inStructEq)																
Outdegree-equivalence (balance)																
GWESPFB																
Convergence[b]																
Overall convergence	.13	.25	.21	.17	.20	.20	.25	.16	.10	.08	.18	.17	.18	.08	.18	.21
Maximum absolute t-ratio	.03	.03	.06	.04	.03	.04	.04	.08	.03	.05	.05	.04	.10	.04	.05	.06
Goodness of fit[c]																
Outdegree distribution	.63	.20	.18	.12	.09	.98	.99	.57	.47	.08	.53	.07	.13	.94	.15	.63
Indegree distribution	.20	.53	.25	.97	.73	.91	.77	.43	.92	.45	.86	.58	.94	.53	.86	.92
Geodesic distance	.32	.07	.34	.22	.39	.32	.08	.19	.25	.82	.93	.01	.39	.91	.79	.75
Triad census	.59	.87	.11	.65	.16	.05	.47	.73	.85	.56	.67	.32	.40	.99	.43	.88

Table 3.1 Continued.

Victimization networks	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Rate period 1 (t1-t3)															
Rate period 2 (t3-t5)															
Outdegree (density)															
Outdegree at least 1															
Sex alter															
Sex ego															
Same sex															
Newcomer ego															
Grade alter															
Grade ego															
Same grade															
Same class now															
Same class before															
Additional effects[a]															
Outdegree at least 2															
Outdegree at least 2 x time															
Indegree at least 1															
Reciprocity															
Outdegree-activity (sqrt)															
Indegree-popularity (sqrt)															
Indegree-popularity															
Indegree-popularity x time															
Transitive ties															
Indegree-equivalence (inStructEq)															
Outdegree-equivalence (balance)															
GWESPFB															
Convergence[b]															
Overall convergence	.10	.17	.23	.15	.10	.13	.24	.15	.16	.13	.22	.14	.12	.24	.21
Maximum absolute t-ratio	.05	.02	.04	.06	.05	.03	.03	.05	.04	.02	.04	.04	.04	.06	.07
Goodness of fit[c]															
Outdegree distribution	.26	.74	.20	.83	.77	.99	.99	.87	.52	.80	.88	.10	.93	.65	.79
Indegree distribution	.06	.25	.59	.21	.15	.94	.46	.14	.10	.93	.64	.24	.76	.25	.96
Geodesic distance	.19	.10	.91	.73	.39	.29	.06	.01	.33	.07	.46	.97	.81	.94	.01
Triad census	.15	.52	.56	.85	.18	.69	.09	.69	.64	.27	.27	.21	.77	.46	.33

Notes on Table 3.1. All models were analyzed using 10,000 iterations for better convergence and reliability of the parameter estimates and standard errors. Included effects are indicated in gray (otherwise white). In some of the smaller schools, the rate parameters had to be fixed (at the observed value) to stabilize the estimation process (colored dark gray). [a]In other schools, effects were included to improve the model fit (see additional effects). [b]The overall convergence of each school network model is assessed with the overall convergence ratio reported in the SIENA output file. [c]For the assessment of the Goodness of Fit (*p*-values are reported; *p*-values ≥ .05 indicate acceptable fit) we re-analyzed all network models using the method of structural zeros for composition changes (1,000 iterations were used) instead of the method of joiners and leavers (see the RSiena manual for a detailed explanation). Three schools (colored light gray school 12, 24, and 31) did not show optimal fit on geodesic distance, specifically indirect ties in these three schools were not well modeled. RSiena short names for outdegree (and indegree) "equivalence" mentioned in parentheses.

i nominates *j* as his or her bully). *Out-degree isolates* is included to inversely indicate that students are not likely to start sending bully nominations to schoolmates (non-victimized students or having zero out-degree). By including these three basic structural effects, it was possible to capture many of the network properties of the school-wide victim-bully networks (as indicated by fit statistics). For most school networks, one or two additional effects were necessary to capture dispersion in out- or in-degrees (referring to individual differences in sending and receiving bully nominations).

Next to these structural effects, we included effects related to sex and grade, to account for sex and grade differences in victim-bully ties by including alter, ego, and similarity effects. The *alter* and *ego* effects indicate that boys or higher-grade students are more likely to receive and send bully nominations than girls or lower-grade students; the *same-sex* and *same-grade* effects indicate that victim-bully ties are more likely to be formed among same-sex or same-grade students than among cross-sex and cross-grade students. The combination of these three effects is necessary to adequately capture selection tendencies based on sex and grade in the victim-bully networks (Snijders et al., 2010).

Are newcomers in the classroom more likely to become victims?

To answer our first research question we included an ego effect for newcomers. This *newcomer ego* effect assessed whether newcomers were more likely to start sending bully nominations than established classroom members (H1).

Does a stable classroom lead to less change in bully nominations?

To answer our second research question we included three parameters. To test H2, the *same class before* effect assessed whether the formation of victim-bully ties was more likely among students who had been classmates before. To test H3, the *same grade* effect was included. To test H4, the same class now effect, tests whether changes in victim-bully ties are more likely among same classmates being in the same classroom concurrently.

Additional analyses

To assess effect sizes, we calculated the relative importance of each effect on the probability of a tie change (Indlekofer & Brandes, 2013). For this analysis, each school was analyzed using the exact same model specification to ensure the comparability of model parameters and relative effect sizes across schools. The parameter estimates of these models were not very different from those in the full models (see Table S3.3 and Table S3.5 in the Supplements).

3.6 Results

3.6.1 Descriptive findings

Table 3.2 summarizes the descriptive information on the sample and network characteristics. Table S3.2 in the Supplements provides information for each school separately. Table 3.3 summarizes this information per school type (stable, unstable administrative multigrade, and unstable pedagogical multigrade).

The density of the school-wide victim-bully networks was relatively low (average density was .019 at T1; see Table 3.2), which is due to the fact that density takes into account network size. At the first time point, children nominated on average 1 to 2 other schoolmates who victimized them (average degree); this varied between schools (minimum = 0.6, maximum = 3.5; see Table 3.2). Children's involvement in victim-bully relationships decreased over time: whereas most children at time 1 received a bully nomination (sinks), sent one (sources) or both sent and received one (actives), this was no longer the case at time 3 and time 5 (increasing number of isolates).

Victimization occurred equally often among same-sex and cross-sex peers per and between school types (Table 3.3). Occurrence of victimization was also similar across school types, whereas same-grade victimization was higher in stable schools compared to the two unstable school types. Almost three-quarters of victim-bully ties were within classroom, and this was similar in all three school types.

Victim-bully ties were unstable from one time point to the next: Many new victim-bully ties were created and even more victim-bully ties dissolved each school year. This can also be seen in Figure 3.1, where the number of victim-bully ties decreases significantly over time. Only about 10% of the victim-bully ties were stable from one time point to the next. This did not much differ between the three school types (Table 3.3). Over 50% of the victim-bully ties at time 3 and time 5 were between children who had shared the same class before; this was higher in stable schools than in unstable (administrative and pedagogical multigrade) schools.

Table 3.2 Descriptive statistics of individual, dyadic, and network change characteristics summarized for all 31 school-wide victim-bully networks (n = 3,254 students).

Sample	T1	T3	T5
Network (schools)			
School size	92 (27-261)	87 (20-195)	71 (20-182)
Percentage of boys	49% (35-63%)	49% (38-61%)	48% (31-64%)
Density	.019 (.004-.05)	.014 (.004-.042)	.013 (.001-.04)
Average degree	1.5 (0.6-3.5)	1.1 (0.3-2.1)	1.1 (0.2-3)
Number of ties	113 (11-324)	79 (8-280)	49 (3-144)
Mutual ties	9 (0-46)	4 (0-24)	2 (0-8)
Total sample (students)			
Sinks[a]	23.3% (12.5-36.3%)	21.6% (10.9-42.1%)	16.3% (7.5-27.5%)
Sources[a]	16.4% (5.7-39.6%)	14.3% (4.5-22.6%)	11.8% (5-20.4%)
Isolates[a]	41.3% (8.3-79.5%)	53.2% (15.8-81.2%)	65.4% (52.9-87.5%)
Actives[a]	19% (1.9-47.5%)	10.9% (0-32%)	6.6% (0-16%)
Dyadic variables			
Same sex	51% (26-71%)	54% (14-88%)	55% (21-83%)
Same grade now	61% (16-97%)	56% (12-91%)	59% (25-89%)
Same class now	74% (39-91%)	72% (34-97%)	74% (33-97%)
Sample change	**T1-T3**	**T3-T5**	
Totals			
Joiners in school	3 (0-9)	4 (0-14)	
Joiners in classroom	1 (0-9)	1 (0-9)	
Leavers	8 (0-40)	25 (5-60)	
Stayers	89 (18-221)	68 (18-173)	
Tie change			
Creating tie (0 → 1)	57 (4-209)	30 (2-107)	
Dissolving tie (1 → 0)	78 (5-238)	39 (3-113)	
Stable tie (1 → 1)	15 (0-56)	8 (0-26)	
Jaccard index[b]	8.9% (0-24.4%)	10.3% (0-24.1%)	
Individual variables			
Newcomer[c] (corr)	.14 (-.07-.36)	.19 (-.02-.41)	
Dyadic variables			
Same grade before[d]	55% (12-91%)	58% (25-89%)	
Same class before[d]	47% (12-73%)	50% (24-81%)	

Notes. Table reports averages, minimum and maximum in parentheses. [a]Sinks are actors with zero out-ties and at least one in-tie, sources are actors with at least one out-tie and zero in-ties, isolates are actors with zero in-ties and zero out-ties, and actives are children with at least one out-tie and at least one in-tie. [b]The Jaccard index is the fraction of stable ties relative to all new, lost and stable ties. [c]Correlations between number of bully nominations send and continuous scores for newcomers. Correlations were summarized using Fisher's r-to-z transformation. [d]Percentage of ties in T3 or T5.

Table 3.3 Descriptive statistics of peer victimization based on individual, dyadic, and network change characteristics summarized for the three school types.

Sample	T1	T3	T5	Sample change	T1-T3	T3-T5
				Stable (8 schools, 1,203 students)		
Network density				Student change		
Density	.012	.008	.008	Joiners in school	5.0	3.8
Average degree	1.5	1.1	1.1	Joiners in classroom	0.2	1.1
Number of ties	191	141	74	Leavers	5.8	40.4
Mutual ties	17	10	4	Stayers	135.9	100.5
Total sample (students)				Tie change		
Sinks[a]	26%	25%	18%	Creating tie (0 → 1)	105	51
Sources[a]	17%	15%	12%	Dissolving tie (1 → 0)	138	76
Isolates[a]	33%	44%	63%	Stable tie (1 → 1)	28	15
Actives[a]	25%	16%	8%	Jaccard index[b]	9.8%	10.6%
Dyadic variables				Individual variables		
Same sex	50%	53%	56%	Newcomer[c] (corr)	.01	.06
Same grade	81%	79%	82%	Dyadic variables		
Same class now	79%	73%	75%	Same class before[d]	63%	70%
				Unstable administrative multigrade (18 schools, 1,436 students)		
Network density				Student change		
Density	.024	.017	.015	Joiners in school	2.4	2.3
Average degree	1.6	1.1	1.0	Joiners in classroom	0.7	0.3
Number of ties	87	55	37	Leavers	5.9	18.8
Mutual ties	7	2	1	Stayers	69.2	52.8
Total sample (students)				Tie change		
Sinks[a]	23%	22%	16%	Creating tie (0 → 1)	38	23
Sources[a]	17%	15%	12%	Dissolving tie (1 → 0)	61	26
Isolates[a]	40%	53%	66%	Stable tie (1 → 1)	11	5
Actives[a]	19%	10%	6%	Jaccard index[b]	8.0%	9.7%
Dyadic variables				Individual variables		
Same sex	52%	57%	57%	Newcomer[c] (corr)	.17	.25
Same grade	58%	51%	55%	Dyadic variables		
Same class now	73%	74%	73%	Same class before[d]	45%	45%
				Unstable pedagogical multigrade (5 schools, 615 students)		
Network density				Student change		
Density	.015	.014	.013	Joiners in school	4.2	9.2
Average degree	1.4	1.3	1.2	Joiners in classroom	3.2	2.2
Number of ties	83	66	53	Leavers	21.6	22.2
Mutual ties	3	2	3	Stayers	88.0	70.0
Total sample (students)				Tie change		
Sinks[a]	21%	14%	15%	Creating tie (0 → 1)	45	19
Sources[a]	12%	11%	10%	Dissolving tie (1 → 0)	41	26
Isolates[a]	59%	68%	68%	Stable tie (1 → 1)	11	5
Actives[a]	9%	6%	6%	Jaccard index[b]	10.7%	12.0%
Dyadic variables				Individual variables		
Same sex	49%	41%	46%	Newcomer[c] (corr)	.24	.24
Same grade	39%	42%	38%	Dyadic variables		
Same class now	71%	63%	76%	Same class before[d]	29%	34%

Notes. [a]Sinks are actors with zero out-ties and at least one in-tie, sources are actors with at least one out-tie and zero in-ties, isolates are actors with zero in-ties and zero out-ties, and actives are children with at least one out-tie and at least one in-tie. [b]The Jaccard index is the fraction of stable ties relative to all new, lost and stable ties. [c]Correlations between number of bully nominations send and continuous scores for newcomers. Correlations were summarized using Fisher's *r*-to-*z* transformation. [d]Percentage of ties in T3 or T5.

3.6.2 RSiena findings

Table 3.4 provides the summary of the SIENA findings (using RSiena version 1.1-307), meta-analyzed over the 31 school-wide victim-bully networks. The first column in Table 3.4 shows the mean estimates across all schools. The next column shows the mean estimates across stable schools (as reference), the three other columns show the degree to which administrative multigrade schools and pedagogical multigrade schools deviate from this, taking into account school size. Findings are also summarized for the three different types of schools (stable, unstable administrative multigrade, and unstable pedagogical multigrade), and this will be used to discuss differences in the four effects of main interest (*newcomers*, *same class before*, *same class now*, and *same grade*). Figure S3.4 in the Supplements provides forest plots of these analyses, which are used to inspect outliers.

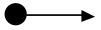
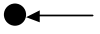
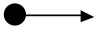
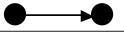
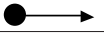
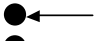
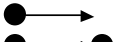
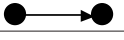
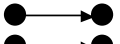
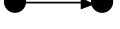
Network effects

The *rate* effects indicate that the average number of changes in bully nominations was 18 between the school years (T1-T2 and T3-T5), with significant variation between schools. In accordance with the low density of the victim-bully networks, the negative *outdegree* (density) effect indicates a low probability of students sending bully nominations to schoolmates. The accompanying negative *outdegree-isolates* effect indicates that students who were not victimized tended to remain non-victimized. Compared to stable schools, outdegree and isolates effects were stronger in unstable (administrative and pedagogical multigrade) schools. Note that outdegree and isolates effects were stronger (positive) in smaller schools, which typically corresponded with unstable (administrative and pedagogical multigrade) schools.

Sex effects

The three included sex-selection parameters in Table 3.5 (*sex ego* effect, *sex alter* effect, and *same sex* effect) are interpreted with so-called ego-alter selection tables, representing the relative contribution to the evaluation function for the four alter and ego sex combinations (Ripley et al., 2019). The positive values on the diagonal in the left panel of Table 3.5 show that victim-bully ties were more likely to be formed among students of the same sex. This was similar between the three school types. In addition, Table 3.5 also shows that girls were rather victimized by boys (positive value for girl sender to boy receiver) than vice versa, more so in pedagogical multigrade schools than in the two other school types.

Table 3.4 Meta-analysis of school-wide victimization networks (31 schools, 3,254 students) – results for all three different school types controlling for school size[a]

	Illustration	n	All schools		Intercept (stable)		Unstable administrative multigrade		Unstable pedagogical multigrade		School size	
			Est.	SE	Est.	SE	Est.	SE	Est.	SE	Est.	SE
Rate effects												
Network rate w1-w3		28	18.53***	1.34[†]	22.06***	2.34[†]	-2.25	3.31	-6.90+	3.83	.294	.242
Network rate w3-w5		27	18.37***	2.35[†]	22.54***	3.59[†]	-.44	5.07	3.37	5.96	1.261**	.386
Network effects												
Density		31	-3.88***	.29[†]	-5.28***	.33[†]	1.24**	.47	2.10***	.58	-0.13***	.035
Isolates		31	-4.06***	.18[†]	-4.73***	.30	.77+	.41	.51	.52	-.037	.030
Sex effects												
Sex (boy) alter		31	.40***	.08	.41**	.13	-.08	.20	.19	.26	-.003	.015
Sex (boy) ego		31	-.18*	.08	-.16	.12	-.01	.19	-.03	.25	.003	.014
Same sex		31	.28***	.08	.22+	.13	.20	.20	-.19	.26	.002	.015
Individual effects												
Newcomer ego		31	.16	.11	-0.07	.19	.35	.28	.32	.37	-.007	.021
Grade effects												
Grade alter		31	.15**	.06	.22*	.10	-.11	.14	-.10	.17	-.003	.010
Grade ego		31	-.15**	.05	-.21*	.10	.11	.14	.003	.17	.000	.010
Same grade		31	1.13***	.11[†]	1.44***	.17	-.45+	.25	-.80**	.28	-.022	.017
Classroom effects												
Same class now		31	.03	.11	.34+	.18	-.25	.25	-.39	.32	.048**	.018
Same class before		31	.02	.09	-.03	.14	.16	.21	.16	.28	.032*	.016
Number of schools			31		8		18		5		31	
Number of students			3,254		1,203		1,436		615		3,254	

Notes. +$p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$. [†]Significant differences between schools. [a]School size was mean centered around the rounded mean school size of the reference category (here stable regular single-grade schools). Intercept represents the "baseline effect" of the reference category. Using density as an example, a 10-unit (estimates and standard errors were multiplied by ten for convenience) increase in school size (referring to +10 above the rounded mean school size of stable schools, which was 150) results in a -0.13 decrease in density in terms of the average effect estimate for a particular school type.

Table 3.5 Bully nominations based on sex (left) and grade (right) summarized across all 31 school-wide victim-bully networks and for the three different school types[a]

A: All schools (31 schools, 3,254 students)

		Bully Sex	
		Girl (0)	Boy (1)
Victim	Girl (0)	.17	.29
	Boy (1)	-.29	.39

		Bully Grade			
		Grade 2	Grade 3	Grade 4	Grade 5
Victim	Grade 2	1.12	.14	.29	.45
	Grade 3	-.16	1.12	.15	.30
	Grade 4	-.30	-.15	1.13	.15
	Grade 5	-.45	-.30	-.15	1.13

B: Stable (8 schools, 1,203 students)

		Bully Sex	
		Girl (0)	Boy (1)
Victim	Girl (0)	.10	.28
	Boy (1)	-.28	.34

		Bully Grade			
		Grade 2	Grade 3	Grade 4	Grade 5
Victim	Grade 2	1.41	.20	.42	.63
	Grade 3	-.22	1.41	.21	.42
	Grade 4	-.43	-.22	1.42	.22
	Grade 5	-.64	-.42	-.21	1.43

C: Unstable administrative multigrade (18 schools, 1,436 students)

		Bully Sex	
		Girl (0)	Boy (1)
Victim	Girl (0)	.32	.27
	Boy (1)	-.27	.48

		Bully Grade			
		Grade 2	Grade 3	Grade 4	Grade 5
Victim	Grade 2	1.06	.08	.21	.33
	Grade 3	-.15	1.09	.11	.23
	Grade 4	-.25	-.12	1.11	.13
	Grade 5	-.35	-.22	-.09	1.14

D: Unstable pedagogical multigrade (5 schools, 516 students)

		Bully Sex	
		Girl (0)	Boy (1)
Victim	Girl (0)	-.16	.40
	Boy (1)	-.38	.25

		Bully Grade			
		Grade 2	Grade 3	Grade 4	Grade 5
Victim	Grade 2	.73	.26	.38	.50
	Grade 3	-.07	.65	.17	.29
	Grade 4	-.27	-.15	.56	.09
	Grade 5	-.48	-.36	-.24	.48

Notes. The values on the diagonal indicate the likelihood of bully nominations when the individual and peer have exactly the same score on sex or grade; The values in the cells in these tables can be transformed to odds by taking the exponential function (exp.(βk)); calculation based on the estimates in Table 3.4. [a]Table 3.1 reports the model specification with all the effects.

Individual effects

We expected that newcomers would be more likely to become victims in schools where the group or classroom is stable over time rather than unstable (H1). The summary across all schools in Table 3.4 shows a positive (non-significant) *newcomer ego* effect across all schools, which indicates that, in some schools, newcomers are more likely to become victimized by peers compared to students who had not changed classrooms. A summary of the three types of schools, shows that contrary to our expectation, this was not the case in the stable schools, but only in the two types of unstable (multigrade) schools (Table 3.4). A positive *newcomer ego* effect was observed in half of the administrative multigrade schools (Figure 3.4 A). A positive effect was also observed in four of the five pedagogical multigrade schools, the other school having a negative effect (Figure 3.4 A).

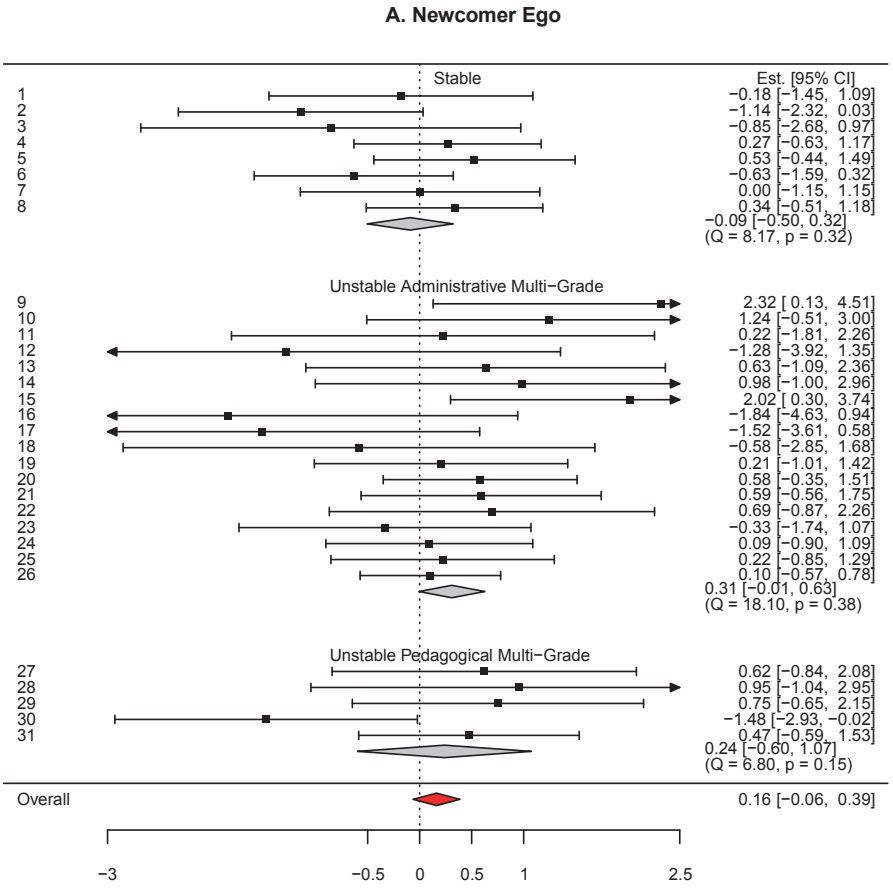


Figure 3.4 A Forest plot of estimates of newcomer ego.

Grade effects

The three included grade-selection parameters in Table 3.4 (*grade ego* effect, *grade alter* effect, and *same grade* effect) are also summarized with ego-alter selection tables in Table 3.5.

The positive values on the diagonal in the right panel of Table 3.5 show that victim-bully ties were more likely to be formed among students of the same grade. We expected to find stronger effects in schools where changes in classroom composition are small (H3). In line with this, we found that students are more likely to be victimized by peers in the same grade, more so in stable schools than in the two other unstable school types (see the larger positive values on the diagonal in Table 3.5; Figure 3.4 B). We also expected that the higher-grade students would target their lower-grade peers, because they form easy targets (H5).

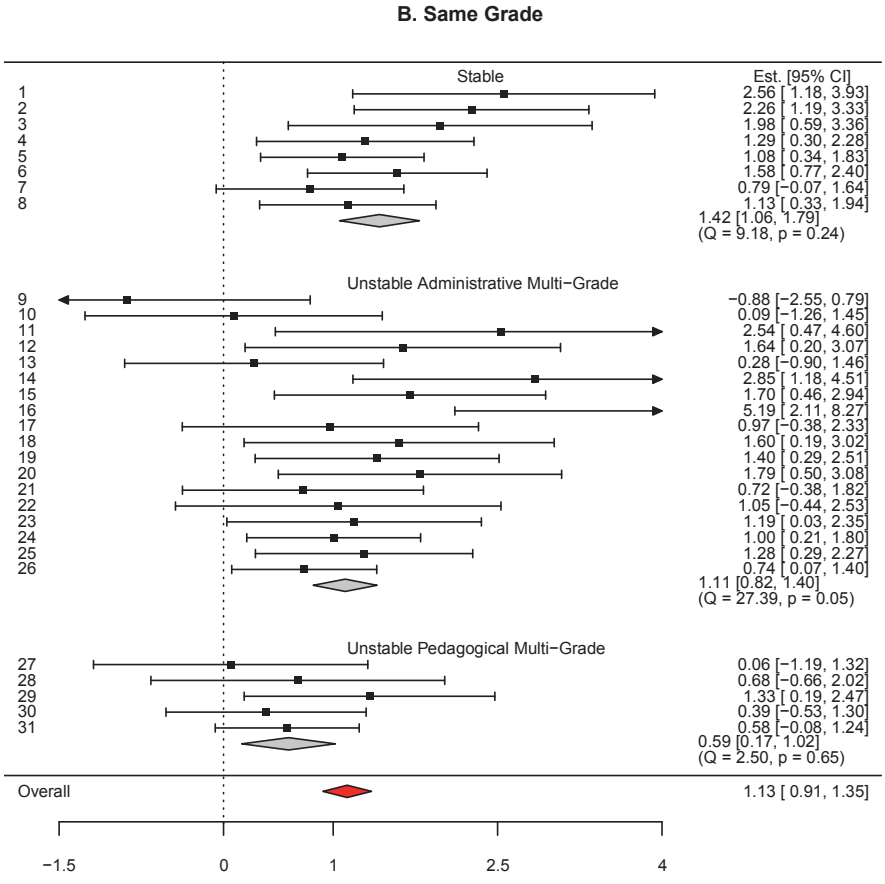


Figure 3.4 B Forest plot of estimates of same grade.

The results were in line with this expectation (positive values in the off-diagonal on the upper right side of Table 3.5), but differences between the three school types were small (Table 3.5).

Classroom effects

The summary across all schools in Table 3.4 shows small (non-significant) effects of *same class now* and *same class before*. Contrary to our expectation, no evidence was obtained for an additional effect on victim-bully relationships being formed between students who shared the same class before (H2). The *same class before* effects were not larger in stable schools compared to the two other unstable school types, when taking into account their present classroom sharing status. The effect was stronger in larger schools (Figure 3.4 D).

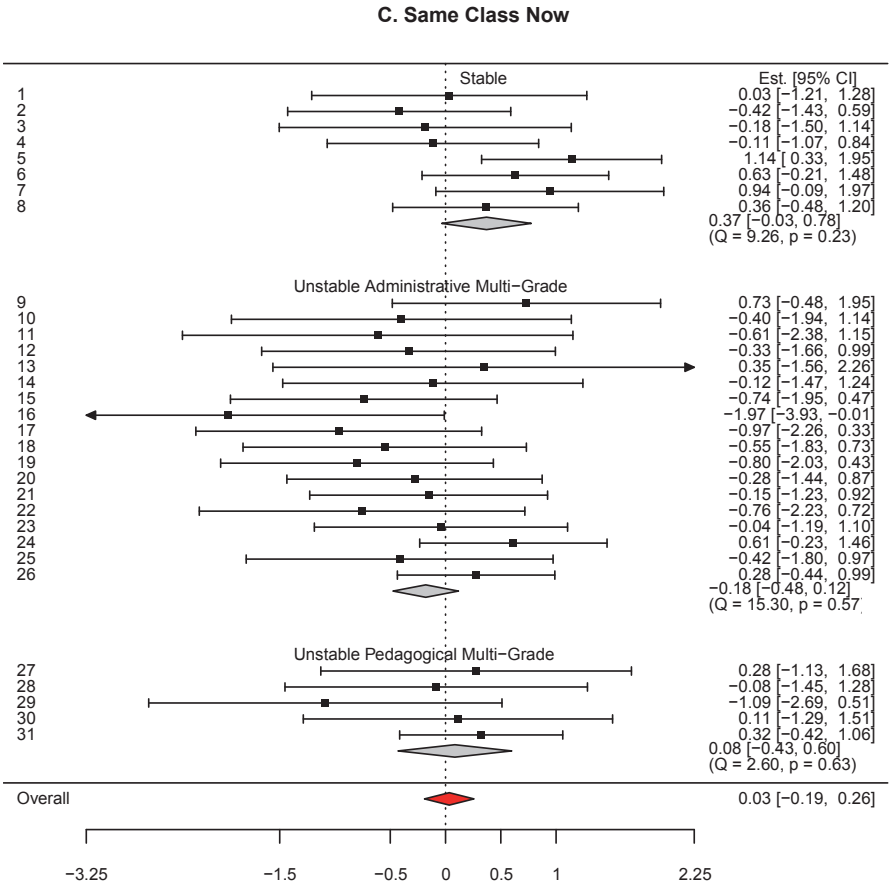


Figure 3.4 C Forest plot of estimates of same class now.

The *same class now* effect was positive in the four largest stable schools (Figure 3.4 C), indicating that victim-bully ties occurred between children who were currently (at T3 and T5) in the same classroom. This effect was as expected (H4) and stronger in larger schools (Figure 3.4 C).

School climate: Administrative versus pedagogical multigrade schools

Finally, we expected to find smaller classroom effects in schools that formed multigrade classrooms based on pedagogical reasons compared to schools that formed multigrade classrooms based on administrative reasons (H6). Our findings provided some evidence for this for same-grade victimization (Figure 3.4 B), whereas the difference in parameter estimates as shown in Table 3.4 is not significant. It should be noted, however, that this

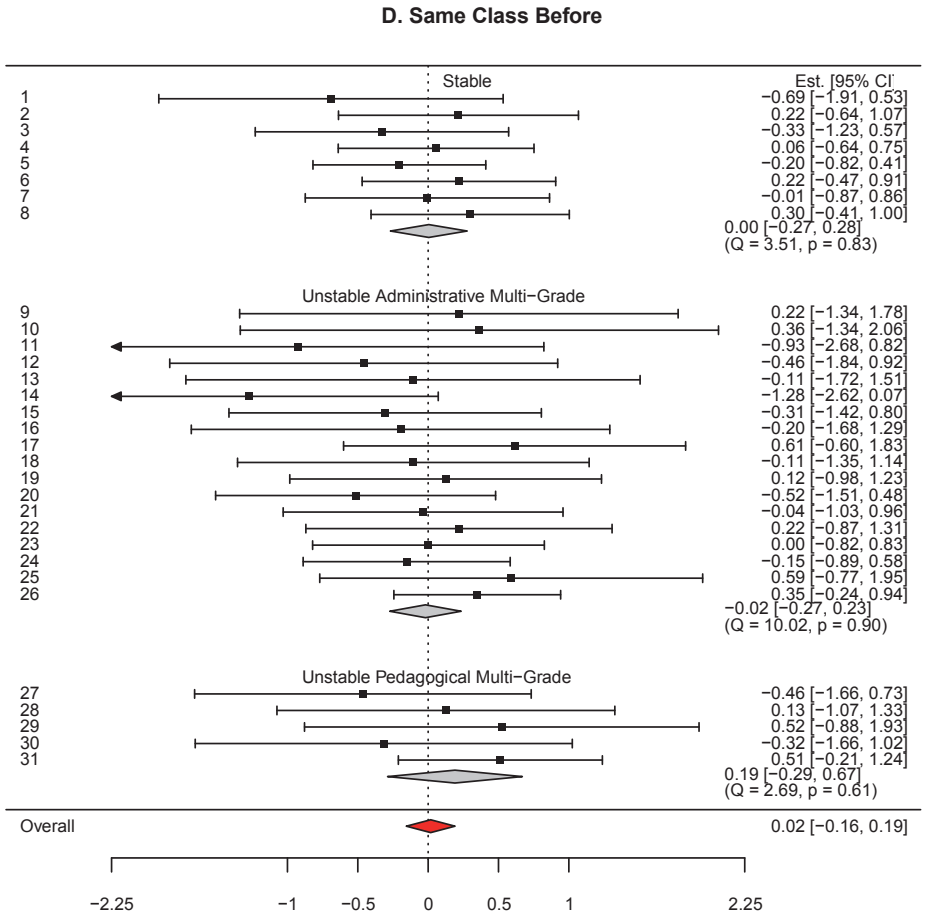


Figure 3.4 D Forest plot of estimates of same class before.

finding is based on a small sample (only five pedagogical multigrade schools were included).

Relative importance of effects

Network structure is the most important determinant of change in the school-wide victim-bully networks (Figure S3.6 in the Supplements). Considering that model fit was generally good, the victim-bully networks are relatively simple in terms of network structure, and were mostly captured by the general tendency to be involved in victim-bully relationships (referring to network density) or to remain uninvolved in such relationships (referring to network isolates). Overall, the density and isolates effects explain 70% of the influence choices for changes in victim-bully ties. This implies that the other effects in the models are (relatively) small (see Figure S3.6 in the Supplements).

Figure 3.5 summarizes the relative effect of the four parameters of main interest in our study (individual effect: *newcomers*; dyadic effects: *same class before*, *same class now*, and *same grade*), where Figure S3.6 in the Supplements provides the complete information. In general, dyadic effects were more important than individual effects in explaining changes in victim-bully ties. In particular, of the three dyadic effects same grade was the most important, although not for all schools. In view of the absence of a pattern in the relative effects in Figure 3.5 no indication was obtained that the strength of effects depends on stability of the classroom composition.

3.7 Discussion

We examined the extent to which stability and change in student classroom composition (referring to the group of students who are in the same classroom together over the school year) affects the formation of victim-bully relationships. Following a relational approach, victim-bully relationships were examined with longitudinal social network analysis. In doing so, our study contributes to the existing bullying literature by providing first insights into the formation and development of victim-bully relationships within the school context by examining changes in victim-bully networks in schools that *do* and *do not* combine classrooms or grades over the school years.

3.7.1 Are newcomers in the classroom more likely to become victims?

Although based on a small number of schools and not significant, the results indicate that newcomers in unstable (administrative and pedagogical multigrade) schools are at risk to become victimized by peers. In stable schools on the other hand, victimization occurs mainly between students in the same grade, with no indication for newcomers being more at risk.

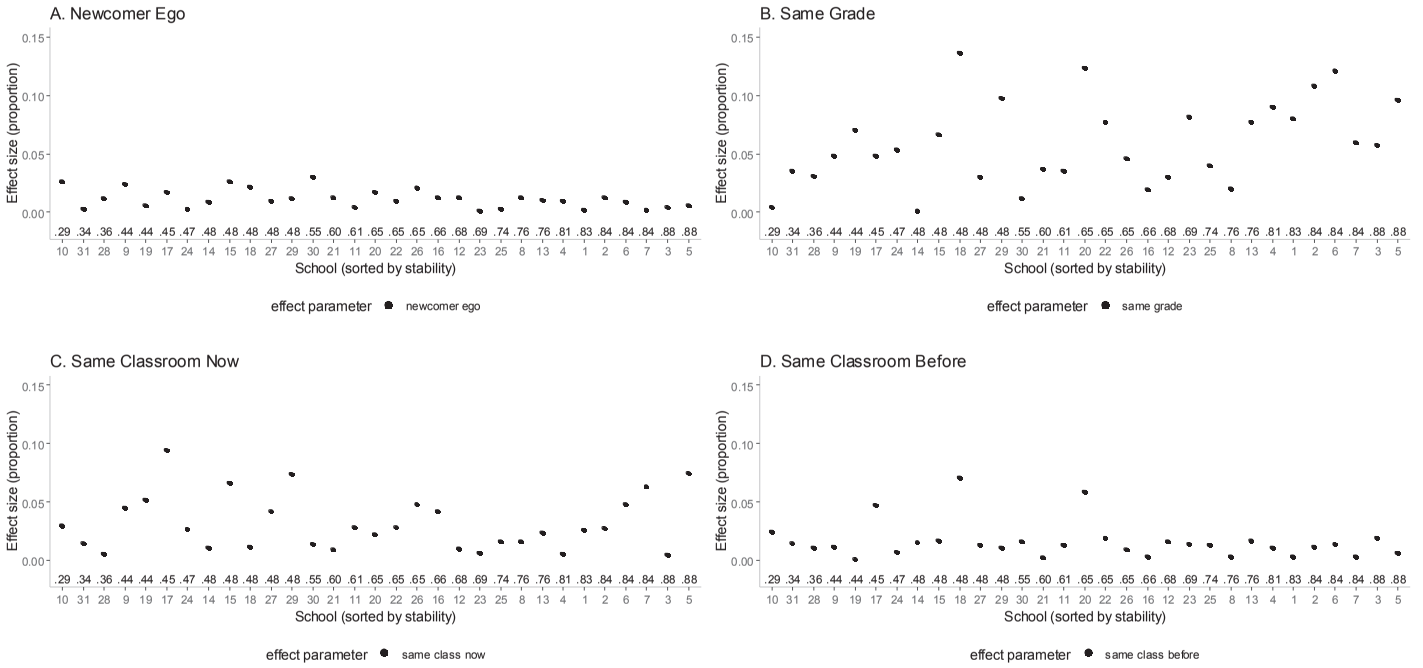


Figure 3.5 Relative importance of effects contributing to peer victimization for the four effects of main interest (A. newcomer ego, B. same grade, C. same class now, and D. same class before).

Notes. Calculated using the exact same model specification for each school (results are reported in Table S3.5 in the Supplements). This figure was created in R (R Core Team, 2013).

An explanation is that a new classroom context, for example, through school transitions, can be a stressful event for many children by disrupting their friendships with peers (Benner & Graham, 2009; Parker, Rubin, Erath, Wojslawowicz, & Buskir, 2006). These negative experiences are associated with loneliness and stress that form risk factors for peer victimization (Farmer et al., 2011a, 2011b; Wang et al., 2016). Research also shows that some children are affected by classroom changes because of disrupted social hierarchies, which requires them to "re-establish" their social position by engaging in aggression or bullying (Pelligrini, 2002).

Classroom mixing may impact positive relationships between students as it could lead to a loss of friendships (Neckerman, 1996), which seems especially problematic for the victims (Hodges et al., 1999; Pellegrini, Bartini, & Brooks, 1999; Sainio et al., 2011). It is plausible that the dispositional or behavioral characteristics of newcomers, for instance, being aggressive, withdrawn, or previously victimized (Geven et al., 2016; Lubbers et al., 2011) are part of the explanation for why newcomers might become a target of victimization. Moreover, other behavioral or reputational risks for victimization, such as low acceptance or an isolated position in the group (e.g., no or few friends), may increase the chance of being victimized. Although not an easy task, taking these individual factors into account in the study of victim-bully networks might lead to a more nuanced understanding of the effects of newcomers in terms of victimization in school. At the same time, classroom mixing offers an opportunity for victims to find new friends or defenders that help victims against a vicious cycle of victimization and its negative experiences (Hodges et al., 1999; Pellegrini et al., 1999; Sainio et al., 2011). An avenue for further research is to understand how victim-bully relationships develop in the context of friendships within stable and unstable schools (for an example in stable peer groups: Rambaran et al., 2019b).

3.7.2 Does a stable classroom lead to less change in bully nominations?

To answer our second research question we tested complementary hypotheses. First, contrary to our expectation, the analyses provided no evidence that students who shared the same class before (referring to the number of shared classrooms) were more likely to be victimized in the stable schools as compared to unstable schools. An explanation might be that change in victim-bully ties is high, as shown in our analysis, and in line with previous findings (Huitsing et al., 2014; Rambaran et al., 2019b). In light of bullying as strategic and goal-oriented behavior (Salmivalli, 2010; Sijtsema et al., 2009; Veenstra et al., 2010), recent research on the dynamic network interplay between bullying and popularity reveals that bullies frequently change victims to maintain a high social status (van der Ploeg et al., 2019). Other recent research also shows that, contrary to conventional notions (Salmivalli, 2010), many children involved in bullying switch roles: they may be a bully at one time point, a victim at another, and uninvolved at the next time point (Zych et al., 2019).

Second, we expected that in a stable school context same grade (typically referring to same classroom) may already capture a large proportion of the victim-bully ties between the children who were classmates before. In line with our expectation, our findings did show that the formation and development of victim-bully relationships occurred more often among same-grade students in stable schools than in unstable multigrade schools. An obvious explanation is that students in stable schools remain together with their classmates from a previous school year. This increases opportunities for bullying between classmates who are in the same grade each year as their classroom composition remains stable. The negligible effect of a shared classroom history in our analyses might thus already be accounted for by being consistently in the same grade over time. Multigrade schools are highly unstable in terms of classroom composition across the school years. However, in this unstable school context bullying occurs more often among same-grade than cross-grade students, and this was more strongly in the administrative multigrade schools than in pedagogical multigrade schools.

To summarize, our analyses showed that although stable classrooms do not necessarily show less change in bully nominations than in unstable classrooms, victim-bully ties are more likely to develop among students in the same grade or same classroom.

3.7.3 Does school climate affect the relation between change in classroom composition and peer victimization?

Pedagogical multigrade schools share many features with administrative multigrade schools, but there is an important distinction: classroom or grade mixing occurs purposefully to foster positive interactions between cross-grade students in a classroom (Lillard & Else-Quest, 2006; Gray, 2011). Our tentative findings suggest that same-grade victim-bully relationships occur less in unstable pedagogical multigrade schools than in unstable administrative multigrade schools and particularly stable schools, but at the same time, there is also a relatively higher chance of cross-grade victimization. This points at a potential trade-off effect: while higher-grade students are encouraged to demonstrate their value as social leaders toward their lower-grade classmates it might also come across as social dominance for lower-grade students, who are then at the bottom of the hierarchy.

3.7.4 Implications, limitations, and directions for future research

Our findings may have implications for school policy about classroom organization. Overall, results of this study suggest that school and classroom stability and change have a small impact on the formation of victim-bully relationships between children. Bullying relationships were found to develop most easily between children in the same grade, more so in stable classrooms than in classrooms with changing classroom composition, with no

clear evidence that newcomers are more at risk of becoming victimized. In addition, rates of bullying relationships appear to be very low in schools with changing classrooms as compared to schools with stable classrooms. To some extent these findings are reassuring for schools that consistently have to deal with changing compositions in their student population. Particularly in small cities or villages where student enrollment declines, classroom sizes become uneven, and the team of teachers is small (Mulryan-Kyne, 2007; Veenman, 1995), schools are often forced to combine classrooms or grades.

Although a direct comparison is not possible, our findings on peer victimization extend previous research on socio-cognitive outcomes, which also found no clear indication that children in administrative multigrade classrooms are worse off in terms of academic achievement and social adjustment (Mulryan-Kyne, 2005; Veenman, 1995, 1996; but see Mason & Burns, 1996). Multigrade schools may be beneficial, however, when they have explicit goals in terms of enhancing the school climate. This stimulates prosocial behavior and the provision of help across the grades within a classroom (Lillard & Else-Quest, 2006; Moller et al., 2008), but also developing less bullying between grademates.

These findings may be useful for school-wide or whole-group interventions. Teachers should be aware of the fact that most bullying-victimization situations occur between students in the same grade or same classroom. As classmates or grademates probably know each other better, the solution lies within the group, for example by developing positive relations and helping behavior between members of the classroom. This is supported by recent research on the effects of intra-school dynamics among peers, showing that a positive school climate enhances friendships and acceptance of others (Cornell et al., 2015; Fink et al., 2018; Rivas-Drake et al., 2019; van Ryzin & Roseth, 2018).

Not only the potential importance of school climate and classroom stability but also other school factors are worth considering (Juvonen, 2018; Juvonen & Graham, 2014). Where it was argued that peer dynamics and hierarchies might differ across the different school settings, it is not unlikely that also within the same school setting the dynamics might differ, across classrooms, or grades. However, a clear-cut measure of peer hierarchy, dominance or classroom norms is not readily available and is a topic of study on its own (Rambaran, van Duijn, Dijkstra, & Veenstra, 2019c; Salmivalli, 2010).

We measured peer victimization by asking the victims to nominate their bullies (referring to *by whom are you bullied?*). We note that by doing so we did not take into account the perspective of the bullies. It is plausible that some of the bullies did not consider themselves as a bully of (some of) the victims who nominated them, which would lead to a discrepancy

(low agreement) between both sources of informants (Oldenburg et al., 2015). An avenue for future research is to validate our findings by examining victim-bullying networks using a multi-informant approach, with the perspectives of both the victims and the bullies.

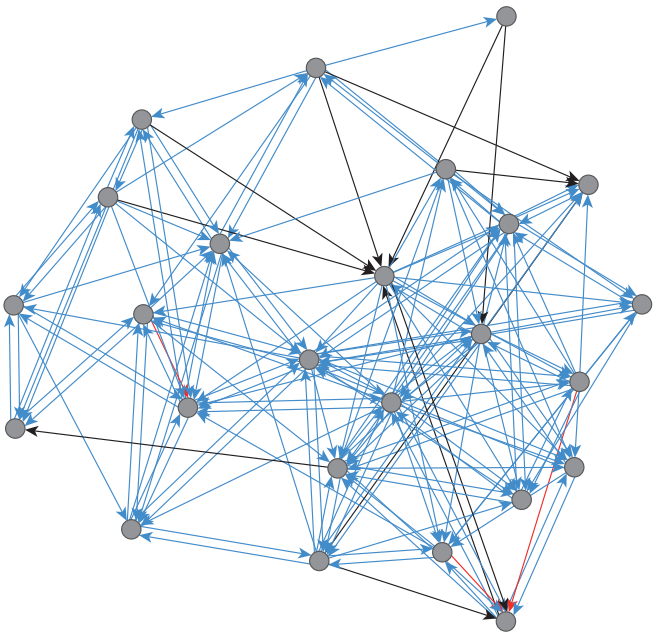
Future research would also benefit from examining victim-bully networks in adolescence as bullying processes are likely to differ between childhood and adolescence. The number of bullies increases or remains stable in early adolescence, whereas the number of victims decreases during this time (Nansel et al., 2001; Pellegrini & Long, 2002). This increase in bullying during early adolescence is followed by a decrease during mid- and late adolescence (Kretschmer, Veenstra, Deković, & Oldehinkel, 2017), which suggests that victims are especially in a vulnerable position in early adolescence when bullying peaks. Investigation of victim-bully networks in adolescence may be more complicated than in childhood because adolescents have more diverse social interactions with peers in school and outside of the own school context. Within school, students share the same homeroom but switch classes on a daily basis as they start to follow different school programs (school courses and school subjects). Outside of school, adolescents are often online or meet others that they know from their neighborhood, or the sport club.

3.7.5 Conclusion

Our study shows that the impact of stability and change in classroom composition on victim-bully relationships was relatively small: students who shared the same class before were not more likely to be victimized in the stable schools as compared to students in unstable multigrade schools. Next to the general tendency to form victim-bully ties or to remain uninvolved in victim-bully ties over time, same-grade victimization appeared to be the strongest predictor of victim-bully ties, particularly in stable schools. In view of the strong same-grade effects, there was no extra effect to be found of being in the same classroom before. The formation and development of victim-bully relationships among students within the same grade was weakest in unstable pedagogical multigrade schools, after controlling for school size. Taken together, the findings highlight that a context-specific approach may be necessary to tackle bullying in stable and unstable schools.

Chapter 4

Bullying as a Group Process in Childhood: A Longitudinal Social Network Analysis



This chapter is based upon:

Rambaran, J.A., Dijkstra, J.K., & Veenstra, R. (2019). Bullying as a Group Process in Childhood: A Longitudinal Social Network Analysis. *Child Development*, doi:10.1111/cdev.13298

This study investigates the dynamic interplay between bullying relationships and friendships in a sample of 481 students in 19 elementary school classrooms (age 8-12 years; 50% boys). Based on a relational framework, it is to be expected that friendships would be formed when two children bullied the same person and that children would start to bully the victims of their friends. Similarly, it is to be expected that friendships would be formed when two children were victimized by the same bully and that children would become victimized by the bullies of their friends. Longitudinal bivariate social network analysis supported the first two hypotheses, but not the latter two. This study provides evidence for group processes in bully-victim networks in childhood.

Keywords: social networks; bullying and victimization; peer group processes

4.1 Introduction

School bullying affects the lives of many children. Victims of school bullying often experience weak social support, rejection, and social isolation that can be detrimental to their socio-emotional development, such as weak social bonding, poor academic performance, and elevated levels of anxiety and depression (Rivara & Le Menestrel, 2016; Kochenderfer & Ladd, 1996). Children who transgress toward peers by bullying, in contrast, often experience support from peers, for example, by peers who assist in harassing the victim (Salmivalli, 2010). The negative consequences for those who bully others have also been well-documented, such as low academic functioning in school to more serious offending later in life (Rivara & Le Menestrel, 2016).

The social components of bullying suggest that it is a group process (Salmivalli, 2010). This idea stems from the participant roles approach (Salmivalli et al., 1996), which emphasizes the social nature of bullying. Bullying often takes place at school, where victims are unable to avoid their bullies. Victims are often harassed by multiple bullies and because of fear of rejection, only a few may defend the victim. Peer group members tend to have similar involvement in aggressive and bullying behaviors (Espelage et al., 2007; Espelage et al., 2003; Haselager, Hartup, van Lieshout, & Riksen-Walraven, 2008; Salmivalli, Huttunen, & Lagerspetz, 1997). Similarity between friends in aggression and bullying may be driven by selection, referring to that aggressive children want to affiliate with each other (Cairns &

Cairns, 1994), or by influence, referring to that friends become increasingly more similar in their behaviors over time (Poulin & Boivin, 2000; Salmivalli & Voeten, 2004; Guerra et al., 2011; Werner & Hill, 2010). Previous studies on dynamics in networks and behavior found no clear evidence that bullies select each other as friends or that bullies influence their friends in adolescence (Caravita et al., 2014; Merrin et al., 2018; Sijtsema et al., 2014; Sentse et al., 2014).

An explanation for the lack of support is that these previous network studies examined bullying as individual behavior. However, researchers have come to recognize that bullying is relational and that we should examine *who bullies whom*. From this relational or status framework (Rodkin et al., 2015; Veenstra et al., 2007), it can be argued that bullies choose their friends and victims strategically. Aside from social affection, bullies also strive for social status (Salmivalli, 2010; Veenstra et al., 2010). By targeting the weaker individuals in the group, they are able to create a power imbalance with their victims without losing affection from peers (Salmivalli, 2010; Veenstra et al., 2010). In order to maintain a high social status, friends may serve as social support during bullying incidents as well as help against defenders of victims. In line with this idea, recent empirical work on the interplay between positive and negative relationships showed that children who bullied the same person tend to defend each other (Huitsing et al., 2014). Other work also showed that adolescents who are befriended dislike the same persons (Rambaran, Dijkstra, Munniksma, & Cillessen, 2015). These studies also suggest that sharing the same victims, dislikes or enemies foster positive affect between individuals, and increases the motivation to befriend each other. We build on these previous network studies by investigating the longitudinal interplay between friendships and bullying relationships in middle childhood to early adolescence.

4.2 Theory

4.2.1 Bullying roles in the group

Empirical research on bullying dates back to the 1970s in Scandinavia (for a brief review, see Hymel & Swearer, 2015), where it was labeled "mobbing," referring to "school children repeatedly ganging up on the same victims" (Lagerspetz, Björkqvist, Berts, & King, 1982, p. 45; Olweus, 1978). It was argued that bullying typically involves the same individuals, bullies, who single-out others as targets of victimization. Bullies were found to be not only physically stronger than their victims (portraying a power imbalance), but also better adapted in the group (e.g., more popular). Although researchers already spoke of a group process in explaining bullying, the emphasis was put on specific bullies and specific victims.

The participant roles approach extends this line of research by considering that peer

witnesses are present when bullying takes place and that it matters how these so-called bystanders react to the bullying (Salmivalli et al., 1996; for a review, see Salmivalli, 2010). It was demonstrated that children have different roles in the bullying process. In addition to being bullies and victims, children can be assistants or reinforcers of bullies (e.g., by joining in or making fun of victims), outsiders (e.g., those who withdraw), or defenders of victims (e.g., those who help or comfort them). Children who value social status might select into bullying groups, by joining in, as a way to enhance their own social standing in the group (Witvliet et al., 2010). Within bully cliques, children might reinforce each other's bullying behaviors, by providing positive feedback through verbal and non-verbal cues (e.g., smiling or laughing), which might be socially rewarding (Salmivalli, 2010). This process is a form of peer influence, referring to bullies influencing their friends.

4.2.2 Middle to late early adolescence

Middle childhood to early adolescence is an important period to examine selection and influence in bullying behaviors because children attach great value to developing positive relationships with peers during this time (Poulin & Chan, 2010). Friendships may provide children companionship, intimacy, loyalty, and affection, and influence their behaviors. Friendships, however, are moderately stable as children regularly lose old friendships while forming new ones. In the period from middle childhood to early adolescence, children become also aware of their own and others' positions and roles in the group (Kolbert & Crothers, 2003). During this time, these positions and roles are moderately stable (Salmivalli et al., 1998) and many children switch bullying roles: they may be a bully at one time point, a victim at another, and uninvolved at the next time point (Zych et al., 2019). Stability and change in friendships are also linked to involvement in bullying (Poulin & Chan, 2010). Victims often maintain friendships with other victims, but experience difficulties forming friendships with non-victims. Aggressive children do not have a hard time making new friends with (non)aggressive children, but have difficulties keeping their friends (Ellis & Zarbatany, 2007). These change and stability processes enable us to assess peer selection and influence in bullying behaviors.

4.2.3 Peer selection and influence

We examine peer selection and influence processes in specific targets instead of general behavior. Thus far, only a few studies used this dyadic approach in longitudinal social network research (e.g., Huitsing et al., 2014; Rambaran et al., 2015). These studies provided insight in the interplay between positive and negative networks and revealed the relational aspects of bullying, disliking, and defending. For instance, a longitudinal study on the interplay between defending relationships and victimization relationships found, among a sample of children in late elementary school, that victims defended each other when they were being

harassed by the same bully; the same was true for bullies with the same victims (Huitsing et al., 2014). Another longitudinal study on the interplay between friendships and antipathies, in which study participants were adolescents, found that friendships were formed when students disliked the same person and that students agreed with their friends on whom to befriend and dislike, but disagreed with their antipathies (Rambaran et al., 2015). We continue this line of research by examining the interplay between friendships and bullying relationships in childhood. In what follows, we present four hypothetical configurations to clarify how friendship selection and influence processes may operate in bullying and victimization relationships.

Bully selection and influence hypotheses

The first configuration describes a situation where two individuals share the same victim, referring to that they bully the same person at the same time (Fig. 4.1: a → c). In this configuration, it is expected that the first person's relationship with the second becomes positive over time (referring to that *i* bullies *h* and *j* bullies *h*, then *i* likes *j*). In other words, when two individuals bully the same person they become friends. We call this the *bully selection* hypothesis, indicating that bullies select each other as friends. This selection effect may be explained by that similarity between two individuals breeds attraction (Byrne, 1971; Byrne & Nelson, 1965), which may provide social support and behavioral confirmation to the bullies. An alliance also secures one's position in the group and offers protection against threats (Huitsing et al., 2014; Sainio et al., 2011). Bullies may protect themselves against potential retaliation from their victims or classmates who defend victims (Huitsing et al., 2014). Hence, bullies with the same victim may form alliances through friendships to obtain a strong position in the group, which may discourage others to side with the victim because of the fear to become victims themselves (Pozzoli & Gini, 2010).

The second configuration describes a situation where two individuals are friends, and, at the same time, one of them bullies someone else (Fig. 4.1: b → c). In this configuration, it is expected that the second person's relationship with the third person becomes negative over time (referring to that *i* likes *j* and *i* bullies *h*, then *j* bullies *h*). In other words, when a friend bullies someone, the person will bully that same person as well. This effect may be seen as an influence effect (Rambaran et al., 2015), as it indicates that bullies influence their friends into 'agreeing' on whom to victimize. Hence, we call this the *bully influence* hypothesis. It may be explained by the popularity of the bullies. Bullies are generally not well-liked by peers but can be popular when bullying associates with status in the group (Salmivalli, 2010). For some children, popular peers form role models. They may conform to or mimic their behavior in pursuit of similar status among peers (referring to a social reward; see Brechwald & Prinstein, 2011), or to receive affection from popular friends. Popular kids

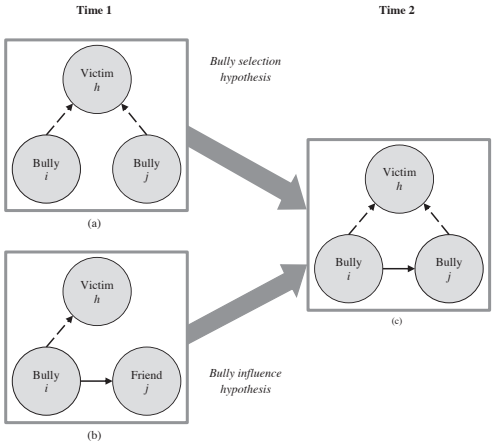


Figure 4.1 Illustration of interplay between bullying ("Who do you bully?") and friendship ("Who is your friend?). As can be seen, the same outcome (c) can be produced by different underlying processes. By (a) two children who bully the same victim at time 1 become friends at time 2 (describing a selection process), and (b) a person who is friends with a bully at time 1 starts to bully the same victim at time 2 (describing an influence process). To facilitate the interpretation of these network configurations, friendships are represented with solid lines and bullying relationships are represented with dashed lines. This figure is derived from Huitsing et al. (2014).

also possess social strategies and social skills that can be used to persuade or manipulate peers (Sandstrom, 2011).

Victim selection and influence hypotheses

The third configuration describes a situation where two individuals share the same bully, referring to that they are victimized by the same person (Fig. 4.2: a → c). In this configuration, it is expected that the first person's relationship with the second person becomes positive over time (referring to that *i* is bullied by *h* and *j* is bullied by *h*, then *i* likes *j*). This selection effect may be explained by bonding over shared negative experiences (a process of co-rumination; see Rose, 2002). Because rejected children are unattractive and avoided as friends, victims may settle for friendships with each other (a process of default selection; Deptula & Cohen, 2004; Sijtsema, Lindenberg, & Veenstra, 2010). Forming a friendship may also strengthen their position against a common adversary. We call this the *victim selection* hypothesis.

The fourth configuration describes a situation where two individuals are friends, and one of them is victimized by someone else (Fig. 4.2: b → c). In this configuration, it is expected that the second person's relationship with the third person becomes negative over time (referring to that *i* likes *j* and *i* is bullied by *h*, then *j* is bullied by *h*). In other words, when

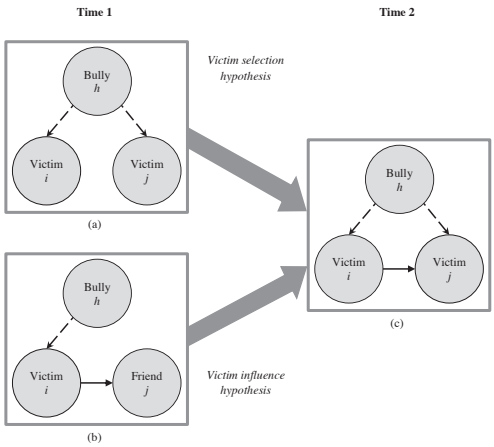


Figure 4.2 Illustration of interplay between friendship ("Who is your friend?) and bullying ("Who do you bully?"). As can be seen, the same outcome (c) can be produced by different underlying processes. By (a) two children who are victims of the same bully at time 1 become friends at time 2 (describing a selection process), and (b) a person who is friends with a victim at time 1 becomes a victim of the same bully at time 2 (describing an influence process). To facilitate the interpretation of these network configurations, friendships are represented with solid lines and bullying relationships are represented with dashed lines. This figure is derived from Huitsing et al. (2014).

a friend is bullied by someone, the person will be bullied by that same person as well. A friendship with a victim may weaken one's own position in the group, thus putting oneself at risk to become the next target. This effect may be seen as an influence effect, as it indicates that there is a contagion of victimization. Accordingly, we call this the *victim influence* hypothesis.

4.3 The present study

We investigate victim-bully relationships together with friendships and use a so-called multiplex social network approach. We expected that bullies start to become friends over time (H1) and that bullies influence their friends to start bullying the same victim (H2). In addition, we expected that victims start to become friends over time (H3) and that bullies start to victimize the friends of their victims (H4). We tested our hypotheses using longitudinal bivariate social network analysis using SIENA (Simulation Investigation for Empirical Network Analysis; Snijders, Lomi, & Torló, 2013). This approach allows us to investigate bullying as a network relationship based on nominations for bullying ("By whom are you victimized?").

4.4 Method

4.4.1 Sample

Classrooms were drawn from the first three waves of the KiVa study collected in May 2012, October 2012, and May 2013. KiVa is a program aimed to reduce school bullying among children in elementary education (8-12 years) in the Netherlands (Huitsing et al., 2019; Kaufman et al., 2018). A total of 99 schools participated in the study. For this study, we selected the four schools in the control condition that did not combine any classes or grades over the school year (after the summer break in 2012). This ensured us to examine group processes in bullying and victimization in stable classrooms. A description of the program, the control sample, and the intervention sample is described elsewhere (Huitsing et al., 2019; Kaufman et al., 2018; Rambaran et al., 2019d).

We applied an additional set of selection criteria for longitudinal social network analysis to the four selected schools that contained 24 classrooms. First, classroom size had to be larger than 15. Second, classrooms had to contain some stable ties. Third, missingness in network information had to be lower than 20%. This resulted in dropping five classrooms (one classroom had 12 students, two classrooms did not have any stable bully-victim tie, and two classrooms did not participate at wave 3). The final sample consisted of 19 classrooms (all single-grades) with 481 students, of which, at the first wave, consisted of five grade 2 classrooms (n = 96), six grade 3 classrooms (n = 184), three grade 4 classrooms (n = 72), and five grade 5 classrooms (n = 129). The average classroom size was 25 (minimum = 20; maximum = 32). Changes in student classroom composition were minimal (we refer the interested reader to Table 4.1 for information about each individual classroom).

4.4.2 Procedure

Students filled in an Internet-based questionnaire in their classroom during regular school hours. The process was administered by the teachers, who were present to answer questions and to assist the students when necessary. Prior to the data collection, teachers were given detailed instructions concerning the procedure. During the data collection, support was available through phone and e-mail.

At the beginning of the questionnaire, students received information about the goal of the study, and how to fill in the questionnaire. They were told not to talk to each other or to discuss their answers when they filled out the questionnaire or afterward to ensure each other's privacy. It was explained to students that their answers would remain confidential. The teachers ensured that students who could not complete the questionnaire on the day of the data collection participated at another day within a month.

Table 4.1 Overview of individual and classroom information for each classroom.

Classroom	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Total size[a]	25	30	20	29	22	24	25	27	24	24	26	26	25	23	23	28	25	23	32
Grade[b]	2 (3)	3 (4)	4 (5)	5 (6)	2 (3)	2 (3)	3 (4)	3 (4)	3 (4)	4 (5)	5 (6)	5 (6)	2 (3)	3 (4)	3 (4)	4 (5)	5 (6)	5 (6)	3 (4)
Age (in years)	8.2	9.4	10.5	11.3	8.2	8.2	9.1	9.2	9.2	10.5	11.4	11.5	8.2	9.3	9.2	10.1	11.4	11.1	9.2
Boys	.60	.40	.45	.41	.46	.54	.56	.63	.42	.46	.39	.50	.32	.61	.57	.50	.52	.65	.63
Respondents[c]																			
Present																			
W1	23	30	20	29	22	24	25	26	24	23	25	24	24	23	22	26	23	23	30
W2	25	30	20	29	21	21	21	27	23	24	26	20	22	23	21	28	25	23	32
W3	25	30	19	29	21	21	22	26	24	24	26	20	22	22	22	28	25	23	31
Missing																			
W1	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	1	0	0	1
W2	0	0	0	0	0	1	3	0	1	0	0	3	0	0	1	0	0	0	0
W3	0	0	1	0	0	0	2	1	0	0	0	1	0	0	0	0	0	0	0
Joining																			
W2	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	2	0	1
W3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leaving																			
W2	0	0	0	0	1	2	1	0	0	0	0	1	3	0	1	0	0	0	0
W3	0	0	0	0	0	1	0	0	0	0	0	2	0	1	0	0	0	0	1
Staying																			
W2	23	30	20	29	21	22	24	26	24	24	26	25	22	23	22	27	23	23	31
W3	25	30	20	29	22	23	25	27	24	24	26	24	25	22	23	28	25	23	31
Average Degree[d]																			
Friendship																			
W1	4.3	4.7	6.1	4.1	5.2	5.3	6.0	6.2	4.5	5.0	4.3	5.2	7.8	5.5	4.7	5.6	4.4	6.1	6.4
W2	7.4	4.9	4.6	4.3	5.2	4.6	3.7	5.9	5.5	6.3	5.7	3.2	6.0	4.8	4.1	6.7	4.9	6.6	7.1
W3	7.2	4.9	3.5	3.7	4.5	4.6	3.7	5.6	3.1	5.3	5.0	3.0	5.0	5.9	3.9	6.6	6.9	6.7	5.8

Table 4.1 Continued.

Classroom	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Average Degree[d]																			
Bullying																			
W1	4.6	1.0	4.2	3.6	3.0	0.7	1.4	2.2	1.7	4.2	0.5	1.7	1.7	1.9	1.4	2.0	1.3	1.7	1.1
W2	1.7	1.2	2.7	2.1	2.1	2.0	4.0	1.3	1.7	3.0	0.2	2.5	1.8	2.5	1.0	3.0	1.4	2.0	1.2
W3	2.2	1.6	3.0	2.2	1.5	2.4	1.4	0.4	2.4	2.6	0.9	1.7	3.1	4.0	2.5	2.0	2.2	0.9	0.8
Number of …[e]																			
Bullies																			
W1	22	11	19	21	16	12	13	23	11	17	11	16	16	17	15	17	18	17	16
W2	14	19	17	18	16	16	19	21	17	14	5	20	13	15	15	21	12	16	18
W3	15	22	19	20	13	11	15	7	18	13	12	20	20	21	16	23	22	12	19
Victims																			
W1	21	15	14	20	15	8	9	7	13	19	7	8	11	8	8	11	7	9	12
W2	12	11	10	12	12	10	15	8	11	11	4	11	8	9	8	10	9	10	9
W3	11	12	8	13	7	14	6	5	10	11	5	7	14	12	12	8	11	4	8
Shared Friendship[f]																			
Bullying																			
W1	.25	.24	.38	.35	.23	.58	.44	.33	.40	.28	.67	.50	.25	.30	.49	.34	.44	.36	.23
W2	.44	.31	.32	.34	.37	.35	.35	.33	.55	.38	1	.34	.37	.26	.50	.32	.50	.48	.40
W3	.48	.29	.26	.25	.26	.42	.40	.44	.17	.41	.46	.26	.26	.29	.37	.30	.42	.57	.33
Victimization																			
W1	.21	.13	.26	.16	.35	.13	.32	.33	.29	.28	.00	.34	.48	.07	.14	.11	.12	.34	.29
W2	.33	.12	.16	.13	.38	.28	.21	.14	.23	.47	.00	.18	.34	.04	.22	.10	.19	.36	.22
W3	.24	.26	.36	.05	.18	.26	.17	.08	.04	.31	.06	.10	.22	.13	.26	.19	.16	.05	.13

Notes. [a]Total network size over all waves, including respondents joining, leaving, and staying. [b]Grade is grade in W1, grade in W2 and W3 is shown in parentheses. [c]Present (missing) are those who belonged to the classroom and who fill (did not fill) out the questionnaire; Joining are those who were new in the classroom in W2 or W3; Leaving are those who left the classroom in W2 or W3; Staying are those who remained in the classroom in W1 and W2 or W2 and W3. [d]Average nomination per respondent for friendship or bullying in classroom; [e]Number of children that sent at least one bully nomination to classmates (bullies) or received at least one bully nomination (victims) from classmates (note that bully nominations were reversed). [f]Proportion of shared outgoing W-ties (*i* and *j* bully the same victim *h*) and incoming W-ties (*i* and *j* are victimized by the same bully *h*) for which there are also outgoing X-ties (*i* and *j* are friends).

Prior to the first measurement (and for students who were new in school, after the first measurement), schools sent information letters to students' parents. A passive consent procedure allowed students or parents to opt out of student participation. At the start of data collection (2012), universities in the Netherlands did not require IRB permission for this type of research. All procedures performed in our study were in accordance with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. A few students did not want to participate and also a few parents objected to their child's participation. Overall, the participation rate was high (98.5% at wave 1).

On each measurement occasion, in an instructional movie, a professional actress explained to students what bullying means, using the following text: "Bullying is when some children repeatedly harass another child. The child who gets bullied has problems defending itself against this. Bullying is not the same as having a fight between two people who are equally strong. Bullying should also not be confused with joking around. Bullying is treating someone repeatedly in a mean way." Several examples of bullying were given to students, including physical and material forms (e.g., hitting someone, kicking or pinching; stealing or damaging someone's belongings) and relational and verbal forms (e.g., making fun of someone, calling names, saying mean things; gossip about someone; excluding from social activities).

4.4.3 Measures

Bullying networks

Bullying was measured with network nominations for peer victimization. At each time point, students were asked to indicate if they were victimized by classmates, and if so, were presented with a roster showing the names of all classmates with the accompanying text: "The following two questions are about who starts the bullying. Often, certain classmates initiate the bullying and others join them." For bullying initiation, they were asked: "Who starts bullying you?" For bullying assisting, they were asked: "Who always joins the bully or is there when the bullying takes place?"

The two items were collapsed into one measure. The overlap between nominations for initiation and assisting was on average 22.7% over the waves, indicating that there is some overlap at the dyadic level between initiating and assisting in bullying. Nominations for the one measure of bullying were reversed so that when *i* considers *j* as his or her bully, this translates into *j* bullying *i* (from the victim's perspective).[1] The perception and experience

1 Note that by "reversing" the bully nominations, I consequently used the term bully-victim, which could be inferred as bullies nominating their victims, which is not the case as victims nominated their bullies.

of victims are important in bullying research. For that reason, we look at bullying from the point of view of the victim. Bully nominations were measured as present (1) or absent (0). Students who indicated not being victimized by classmates did not fill out the nomination questions. Their "answers" were considered as absent nominations. Based on these nominations, bullying networks were obtained containing all directed bully nominations for each classroom.

Friendship networks

Friendship was measured with network nominations. In all waves, students were presented with a roster showing the names of all classmates, and asked whom of their classmates they considered as their best friends ("Who are your best friends?"). Students could choose as many same-sex and other-sex classmates as they wished. Friendship nominations were coded 1 and non-nominations were coded 0, resulting in friendship networks consisting of directed nominations for each classroom.

4.5 Analytic strategy

Analyses were conducted using longitudinal bivariate social network analysis (see for an introduction to this model: Snijders et al., 2013), which allowed for examination of the development of children's friendship and bullying networks simultaneously over time and their interplay (Snijders et al., 2013), while taking structural and individual effects into account. This method has been used before to examine dependencies between positive and negative type networks in (school) classrooms, most prominently friendship and dislike (e.g., Berger & Dijkstra, 2013; Pál, Stadtfeld, Grow, & Takács, 2015; Rambaran et al., 2015; with the exception of Huitsing et al., 2014 who examined dependencies between defending and victimization).

The effects were first analyzed for each classroom model separately, combined over the two observation periods (time 1 and 2; time 2 and 3), and were then meta-analyzed in R (Viechtbauer, 2010). No clear pattern with regard to differences in selection and influence effects were found across time (see Table 4.2).

Each classroom model was estimated with the same specification (see Table 4.3). Parameters were fixed in classrooms where the accompanying statistics (network) configurations were absent (see notes in Table 4.3 for additional information about this). All models showed good convergence (Ripley et al., 2019). In some classroom networks, one or two additional effects were necessary to achieve an acceptable model fit, which is standard practice in social

network analysis for bullying and victimization networks (Huitsing et al., 2014; Rambaran et al., 2019a; Ripley et al., 2019). Initially, a good fit was obtained for 12 out of 19 classrooms, then two more classrooms obtained good fit by including additional effects (classrooms 11 and 15). The remaining five classrooms (3, 12, 13, 14, and 17) had no optimal fit (why these particular classrooms had no optimal fit can be seen in Table 4.4 and Figure 4.3; the notes of Table 4.4 provide a detailed explanation). Sensitivity analysis leaving out these five classrooms yielded substantially the same results. These classrooms were therefore not excluded from the meta-analysis (compare Table 4.7 with Table 4.6).

Table 4.2 Results of time heterogeneity tests of selection effects and influence effects in bullying and victimization.

Classroom	1	2	3	4	5	6	7	8	9	10
Bullying										
Selection	0.76+	0.49+	3.30+	4.52–	0.82–	3.20–	7.63–	0.84+	0.52+	0.19+
Influence	3.14–	0.20+	0.07+	4.51+	0.51–	8.06+	73.27+	3.22–	1.20+	0.47+
Victimization										
Selection	4.44–	1.85–	2.71+	3.74–	0.11+	0.63+	0.28–	0.01+	4.30+	9.53–
Influence	5.70+	0.82–	0.00+	10.54–	0.17+	20.77–	164.60+	2.19–	0.14+	0.01–
Classroom	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	
Bullying										
Selection	4.50+	0.39–	4.02–	0.03+	0.00+	1.07+	1.90+	0.01+	0.48+	
Influence	6.88+	2.02+	0.61–	0.58–	6.37+	3.82–	28.57+	2.04–	NA	
Victimization										
Selection	0.01+	1.30–	4.59–	0.19–	NA	0.10+	0.86–	0.18–	11.06–	
Influence	0.76–	NA	3.88+	1.35+	16.24+	0.74–	0.02–	8.95–	2.07+	

Notes. Table 4.2 shows differences in effect parameters (as reported in Table 4.5) between estimation periods (W1-W2 vs. W2-W3) assessed with chi-square test using sienaTimeTest (Lospinoso, Schweinberger, Snijders, & Ripley, 2011); Significant differences shown in red; Sign shows direction of differences (+ more positive in W2-W3, – more negative in W2-W3). Bullying selection assessed with the "from" effect in RSiena (agreement along W leading to X, where W is an outgoing bullying tie and X is an outgoing friendship tie); bullying influence assessed with the "to" effect in RSiena (W leading to agreement along X, where W is an outgoing friendship tie and X is an outgoing bullying tie); victimization selection assessed with the "sharedIn" effect in RSiena (closure of shared incoming WW → X, where W is an incoming bullying tie and X is an outgoing friendship tie); victimization influence assessed with the "cl.XWX" effect in RSiena (XWX closure of W, where W is an outgoing friendship tie and X is an outgoing bullying tie).

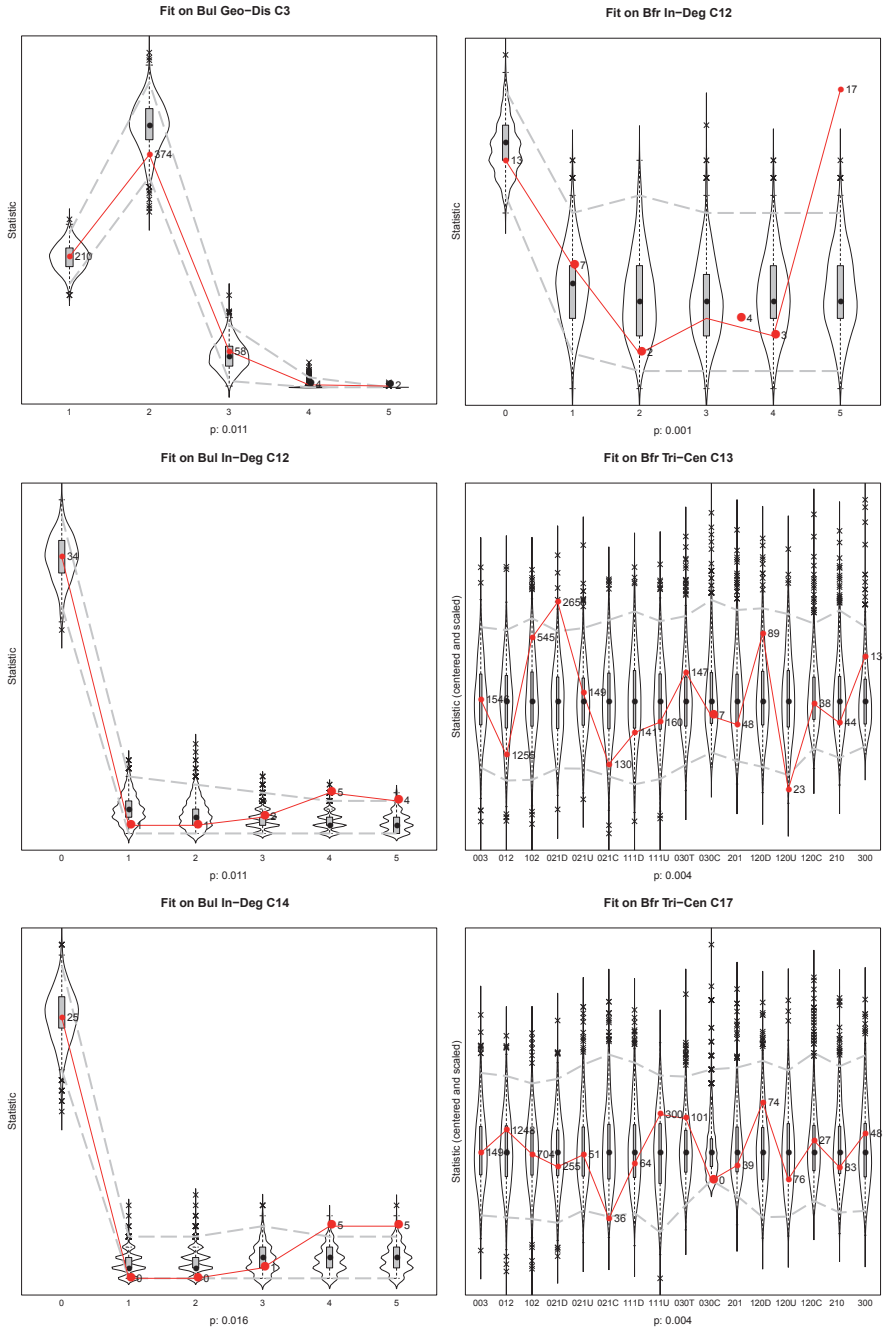


Figure 4.3 Goodness of fit plots for poor fitting classroom network models.

Table 4.3 Effects included in all RSiena multivariate network models.

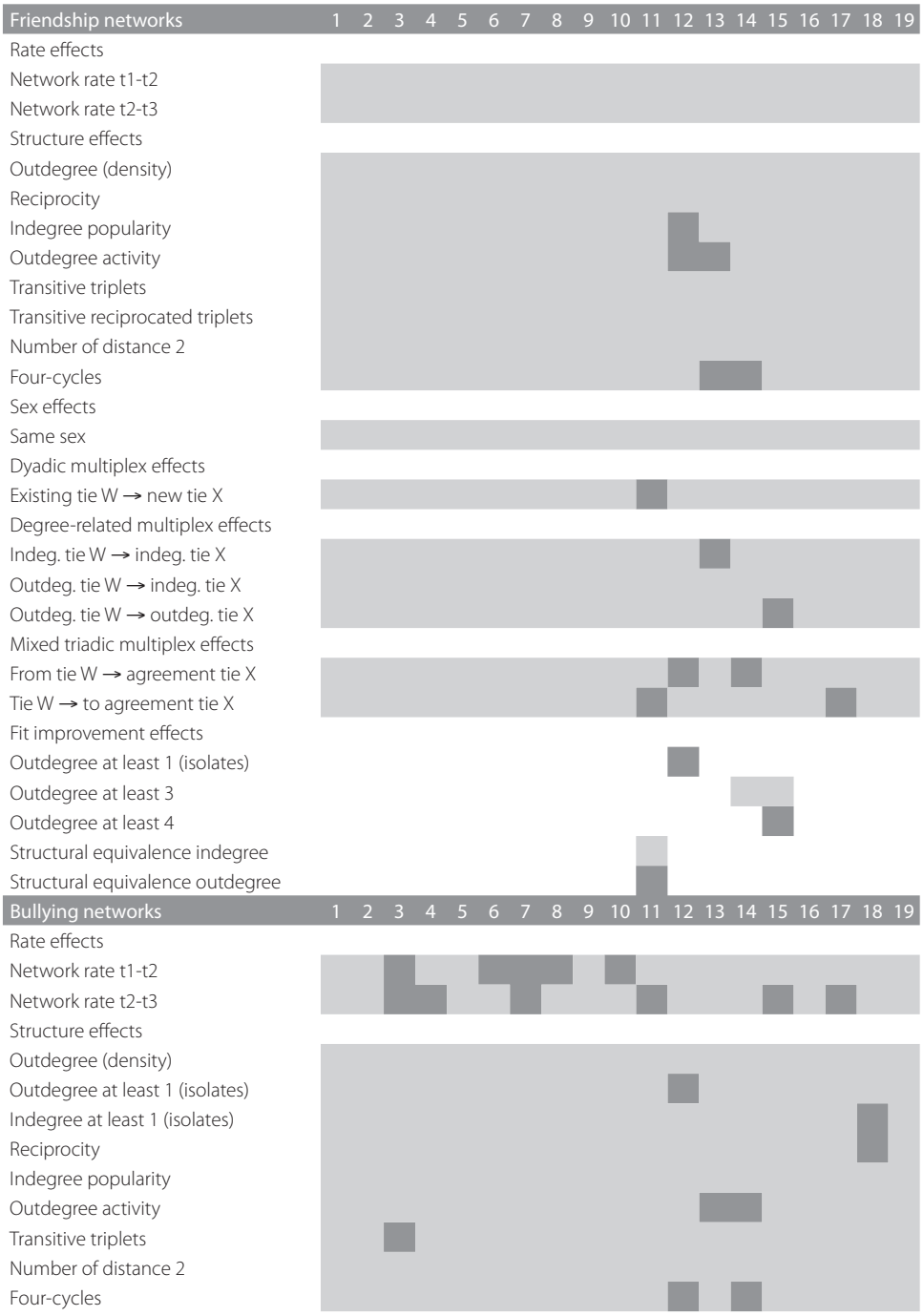
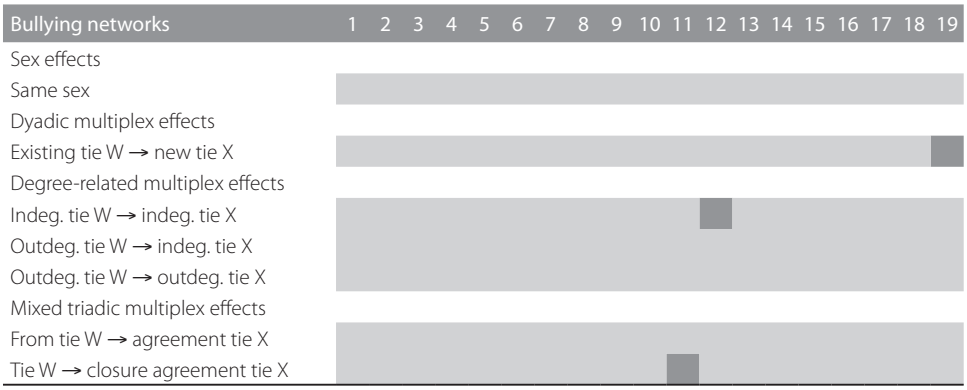


Table 4.3 Continued.



Notes. All models were analyzed using 10,000 iterations for better convergence and reliability of the parameter estimates and standard errors. In some classrooms, the rate effects for bullying became unreasonably high (e.g., larger than 20). As a possible solution, the rate effects were fixed (colored light gray) at the observed value (see Ripley et al., 2019). Other effects were fixed at a non-zero value (based on score-type tests) to obtain convergence when the networks did not carry enough information to estimate them; otherwise effects were fixed to zero (when a non-zero value resulted in non-convergence). Fixed parameters are indicated with dark gray cells. White cells indicate effects *not* included for model fit (only for 'Fit improvement effects').

4.5.1 Model specification

The bivariate analysis in RSiena yields three types of parameters: rate parameters for each type of network (referring to friendship and bullying), selection parameters for each type of network, and between-networks parameters, reflecting the interplay between the two networks. This model specification was largely derived from Huitsing et al. (2014) and Rambaran et al. (2015). The choice of these parameters was based on a combination of three requirements: 1) to include structures that are theoretically relevant for hypotheses testing, 2) to capture adequately the structures in our networks, and 3) to keep the models parsimonious and similar across the classrooms. The final two requirements were assessed using fit statistics and model convergence.

For the structural part of the model for friendship dynamics and bullying dynamics, we included the basic effects (outdegree and reciprocity, indegree popularity, and outdegree activity), network closure effects (actors at distance 2 and transitive triplets), and sub-group effects (four-cycles). For the structural part of the model for bullying dynamics, we also included effects that inversely represent network isolates (indegrees and outdegrees of at least 1). A dyadic covariate effect was included to control for same-sex friendship and bullying.

Table 4.4 Goodness of Fit statistics for RSiena multivariate network models.

		Friendship networks				Bullying networks			
Classroom	Overall convergence	Outdegree distribution	Indegree distribution	Geodesic distance	Triad census	Outdegree distribution	Indegree distribution	Geodesic distance	Triad census
1	.15	.71	.06	.60	.05	.55	.98	.97	.62
2	.14	.20	.82	.37	.22	.64	1	.93	.97
3	.18	.11	.92	.97	.14	.12	.98	.01	.81
4	.16	.26	.41	.91	.14	.72	.13	.85	.10
5	.14	.14	.30	.96	.67	.98	.76	.89	.76
6	.15	.31	.87	.81	.08	.26	.81	.94	.75
7	.15	.84	.81	.34	.79	.85	.96	.59	.57
8	.16	.97	.22	.63	.64	.92	.52	.32	.57
9	.14	.60	.82	.34	.06	.99	.96	.76	.60
10	.17	.52	.67	.99	.19	.87	.69	1	.60
11	.15	.45	.56	.96	.71	.96	.45	.95	.81
12	.20	.29	.001	.38	.18	.44	.01	.49	.86
13	.17	.34	.92	.25	.004	.65	.59	.84	.37
14	.13	.06	.08	.91	.39	.61	.02	.98	.05
15	.16	.22	.85	.99	.85	.92	.79	.91	.99
16	.14	.76	.49	.79	.83	.75	.22	.88	.26
17	.19	.31	.47	.30	.004	.33	.46	.92	.80
18	.14	.14	.41	1	.77	.50	.90	.80	.99
19	.19	.73	.19	.61	.53	.73	.65	.36	.90

Notes. Goodness of fit (GoF) was assessed with four computed auxiliary network statistics: outdegree distribution, indegree distribution, geodesic distance, and triad census. The auxiliary network statistics are important indices for how well friendship or bully-victim patterns in the classroom network are represented with the included model effects or whether additional effects are needed. For each auxiliary statistic, the differences between the values in the observed classroom network (summed across the three waves of data) and the simulated values in the model (summed across 1,000 random networks) are assessed with the Mahalonobis distance (cf. Ripley et al., 2019). Fit for a particular statistic is good or acceptable when the reported *p*-value is larger than .05, indicating that the simulated values do not depart too much from the observed values. This is illustrated in Figure S4.1 in the Supplements with violin plots. These violin plots can be used to inspect whether, for a specific statistic, there are too 'many' (or too 'few' or a 'sufficient' number of) values being simulated in comparison to the observed values with a five percent margin of error. The red solid lines shows the observed values; the boxplots and violins show the distribution of the simulated values. There are several classrooms for which one or more statistics are not well fitted. These are indicated with light gray cells. In five classrooms (classroom 3: geodesic distance for bullying; classroom 12: indegree distribution for friendship and bullying; classroom 13: triad census for friendship; classroom 14: indegree distribution and triad census for bullying; and classroom 17: triad census for friendship), fit was not optimal for one or more statistics. This can also be seen in Figure 4.3. Closer inspection reveals that the model overrepresented the number of indirect bullying relationships for classroom 3. In classroom 12, a few children received a disproportionate amount of friendship nominations at the first moment, but not at later moments; in addition, a non-victimized child at wave 1 was bullied by many classmates later on. In classroom 14, some children were bullied more over time, whereas others were bullied less. A specific triadic configuration was not well represented for friendship in classroom 13 (structural equivalence regarding incoming nominations for friendship) and 17 (indirect connections through one intermediary). Our included parameters did not capture such configurations well. Unfortunately, adding additional effects did not contribute to a better model fit and were therefore not included.

Table 4.5 Descriptive statistics of the friendship networks and bullying networks per and between time points (19 classrooms, 481 students).

	Friendship networks			Bullying networks		
	Wave 1	Wave 2	Wave 3	Wave 1	Wave 2	Wave 3
Density indicators						
Density[a]	.22 (.15-.33)	.22 (.13-.31)	.21 (.12-.30)	.09 (.02-.22)	.08 (.01-.17)	.08 (.01-.18)
Number of ties	135 (108-206)	136 (82-226)	127 (70-185)	52 (14-115)	49 (6-100)	49 (10-93)
At least one out-tie	.94 (.80-1)	.93 (.73-1)	.94 (.69-1)	.65 (.37-.95)	.64 (.19-.85)	.66 (.26-.95)
At least one in-tie	.95 (.84-1)	.94 (.81-1)	.93 (.73-1)	.47 (.26-.84)	.40 (.15-.60)	.37 (.17-.58)
Average degree[b]	5.3 (4.1-7.8)	5.3 (3.2-7.4)	5.0 (3.0-7.2)	2.1 (0.5-4.6)	2.0 (0.2-4.0)	2.0 (0.4-4.0)
SD outdegree	3.9 (2.2-6.5)	3.9 (2.7-5.6)	3.4 (1.9-6.1)	2.1 (0.8-4.4)	2.0 (0.5-3.4)	2.0 (0.8-3.6)
SD indegree	2.9 (2.0-4.0)	2.8 (1.5-3.9)	2.7 (1.6-3.9)	2.9 (1.2-4.6)	3.0 (0.7-5.5)	3.4 (0.9-5.5)
Dyadic indicators						
Asymmetrical ties	122 (80-272)	130 (60-252)	116 (56-198)	88 (24-178)	85 (12-158)	85 (20-126)
Mutual ties	74 (44-122)	71 (46-100)	69 (36-102)	8 (0-32)	6 (0-26)	7 (0-40)
At least one mutual tie	.94 (.80-1)	.93 (.73-1)	.94 (.69-1)	.65 (.37-.95)	.64 (.19-.85)	.66 (.26-.95)
Reciprocity[c]	.55 (.34-.71)	.53 (.41-.63)	.55 (.39-.72)	.13 (.00-.33)	.12 (.00-.26)	.10 (.00-.43)
Sex combinations						
Boy-boy	.35 (.19-.55)	.39 (.22-.63)	.37 (.22-.56)	.33 (.00-.85)	.34 (.04-.76)	.32 (.00-.78)
Girl-girl	.44 (.23-.63)	.41 (.13-.59)	.44 (.18-.65)	.20 (.05-.36)	.19 (.00-.50)	.15 (.00-.38)
Boy-girl	.10 (.04-.21)	.10 (.00-.25)	.09 (.02-.27)	.34 (.03-.57)	.37 (.08-.68)	.39 (.08-.79)
Girl-boy	.11 (.02-.31)	.09 (.00-.23)	.10 (.00-.22)	.14 (.00-.44)	.10 (.00-.35)	.14 (.00-.32)
Triadic indicators						
Distance 2 (indirect ties)[d]	.92 (.72-1)	.91 (.62-1)	.90 (.58-1)	.52 (.16-.95)	.49 (.04-.85)	.55 (.00-.95)
Transitivity index[e]	.51 (.37-.70)	.55 (.39-.74)	.51 (.38-.71)	.38 (.00-.79)	.45 (.00-.75)	.49 (.14-1)
	Wave 1-2		Wave 2-3	Wave 1-2		Wave 2-3
Change indicators						
Creating ties (0 → 1)	55 (20-115)		46 (15-90)	32 (2-86)		29 (6-60)
Dissolving ties (1 → 0)	54 (34-112)		55 (31-108)	35 (10-90)		29 (5-81)
Stable ties (1 → 1)	81 (60-139)		81 (46-124)	17 (1-41)		20 (1-43)
Jaccard index[f]	.43 (.32-.52)		.45 (.29-.56)	.21 (.02-.43)		.24 (.03-.54)

Table 4.5 Continued.

	Friendship * bullying			Friendship * victimization		
	Wave 1	Wave 2	Wave 3	Wave 1	Wave 2	Wave 3
Dependence indicators						
Moran's *I* autocorr.[g]	.18 (-.12-.56)	.20 (-.01-.59)	.22 (.04-.58)	-.01 (-.11-.14)	-.01 (-.19-.21)	-.03 (-.15-.14)
Jaccard index[h]	.06 (.02-.14)	.06 (.01-.09)	.06 (.01-.12)	--	--	--
Shared bullies/ victims[i]	.37 (.23-.67)	.42 (.26-1)	.35 (.17-.57)	.23 (.00-.48)	.22 (.00-.47)	.17 (.04-.36)

Notes. Table shows averages. Minimum and maximum are shown in parentheses. [a]Density is the number of observed ties divided by the total number of possible ties. [b]If counted among the victims (referring to students who nominated at least one bully in class), average degree is 4.4 (min = 1.9, max = 8.4) at W1, 4.8 (min = 1.5, max = 8.5) at W2, and 5.2 (min = 2, max = 7.8) at W3, indicating that victims had, on average about 4-5 bullies in class. [c]Reciprocity was calculated as $2M/(2M + A)$, where M = mutual ties and A = asymmetric ties. [d]Distance 2 is the proportion of respondents with ties at two degrees of separation (with at least one connecting intermediary). [e]Transitivity was calculated as the number of transitive triplets divided by the number of 2-paths (or 2-stars). [f]Jaccard index is the proportion of stable ties in relation to creating ties and dissolving ties. [g]Moran's *I* autocorrelation indicates the level of similarity (as correlation) between friendship and bullying (outdegrees) or victimization (indegrees). [h]Jaccard index is the degree (proportion) of dyadic overlap between friendship networks and bullying networks. [i]Proportion of shared outgoing W-ties (*i* and *j* bully the same victim *h*) and incoming W-ties (*i* and *j* are victimized by the same bully *h*) for which there are also outgoing X-ties (*i* and *j* are friends).

For between-networks effects, the network in the role of dependent variable is denoted by X and the network in the role of explanatory variable by W (see Table 4.3). We tested the dependence of one type of network on another type, controlling for dyadic and degree-related multiplex effects to account for main effects of one network type on another and dynamics in in- and out-degrees between network types and their covariance. The *shared victim to friendship* effect indicates that 'agreeing' upon shared victims will result in the formation of a new friendship tie (Fig. 4.1: a → c) to test the bully selection hypothesis (H1). The *friendship agreement to bullying* effect indicates that an existing friendship tie will result in the formation of a new bullying tie (Fig. 4.1: b → c) and tested the bully influence hypothesis (H2). The same configurations in reversed direction tested the victim selection hypothesis (H3: *shared bully to friendship* effect; Fig. 4.2: a → c) and the victim influence hypothesis (H4: *friendship agreement to victimization* effect; Fig. 4.2: b → c).

4.6 Results

4.6.1 Descriptive findings

Table 4.5 presents the summarized descriptive findings for the 19 classrooms. Table 4.1 reports information per classroom. On average, participants indicated to have five friends and reported to have two bullies (note that this number is higher when counted among the victims; see average degrees in Table 4.5). The majority of students nominated at least one friend (93-94%) or were reported by their peers to bully at least one classmate (64-66%); over one-third were victims (37-47%). Density (proportion of nominations given) was higher for friendship (.21-.22) than for bullying (.08-.09), indicating that bullying networks were sparser. The percentage of reciprocated nominations was also higher for friendships (34-72%) than for bullying (0-43%). Over 75% of friendship nominations and 50% of bully nominations were same sex, and boys bullied girls more often than vice versa. Indirect ties and transitivity were more common for friendships than for bullying (see Table 4.5).

Part two of Table 4.5 shows information about tie stability in friendship and bullying. As shown by the Jaccard indices, all classrooms had sufficient stability in friendship ties between time points (29-56%), but stability in bullying ties was at the most 43% and almost absent in some classrooms. This means that students changed bullying ties more frequently than friendship ties from one time point to the next. For some classrooms, high turnover rates in combination with the model's complexity led to convergence issues. In these instances, we followed recommendations in the RSiena manual (Ripley et al., 2019) and fixed the number of opportunities to change bullying ties at the observed value (see Table 4.3).

Table 4.6 Results from longitudinal multivariate network models predicting co-evolution of friendship and bullying (19 classrooms, 481 students).

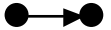
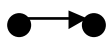
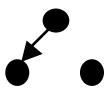
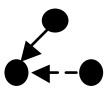
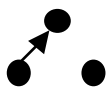
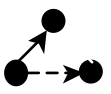
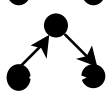
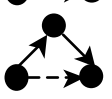
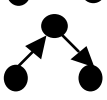
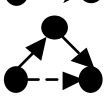
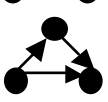
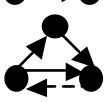
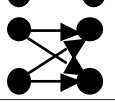
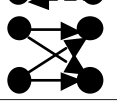
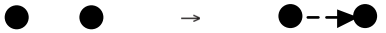
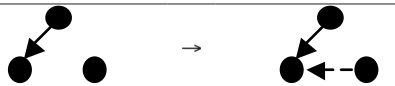
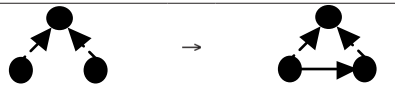
	Hypothetical change			Friendship networks			Bullying networks		
	tx	→	*tx* + *m*	Est.	SE	n	Est.	SE	n
Effect parameters									
Rate effects									
Network rate t1→t2				8.01**	.52[a]	19	7.29**	1.12[a]	14
Network rate t2→t3				8.08**	.57[a]	19	6.82**	.77[a]	13
Structure effects									
Outdegree (density)		→		-2.65**	.21	19	-2.17**	.30[a]	19
Outdegree isolates		→					-1.58**	.31[a]	18
Indegree isolates		→					-2.41**	.25	18
Reciprocity		→		1.61**	.14	19	.37+	.19	18
Indegree popularity		→		.07	.06	18	.02	.07	19
Outdegree activity		→		.02	.04	17	.10	.08	17
Transitive triplets		→		.27**	.08	19	.04	.13	19
Transitive reciprocated triplets		→		-.34**	.09	19			
Actors at distance 2		→		-.20**	.07	19	-.24+	.14	18
Four-cycles		→		-.02	.04	17	-.07	.07	17

Table 4.6 Continued.

	Hypothetical change			Friendship networks			Bullying networks		
	tx	→	*tx* + *m*	Est.	SE	n	Est.	SE	n
Sex effects									
Same sex				.63**	.12	19	.12	.14	19
Dyadic multiplex effects									
Existing tie W → new tie X				-.20	.31	18	-.04	.24	18
Degree-related multiplex effects									
Indegree tie W → Indegree tie X				-.002	.06	18	-.05	.08	18
Outdegree tie W → Indegree tie X				-.15+	.09	19	-.02	.09	19
Outdegree tie W → Outdegree tie X				-.05	.08	18	-.15+	.08	19
Mixed triadic multiplex effects[b]									
H1: shared victim to friendship				.41*	.17	17			
H2: friendship agreement to bullying							.74**	.14	19
H3: shared bully to friendship				.06	.10	17			
H4: friendship agreement to victimization							.03	.12	18

Notes. Significance tests performed by dividing the estimates with its standard error resulting in *t*-Values which under the null hypothesis are approximately normally distributed (Ripley et al., 2019); +$p \leq .10$, *$p \leq .05$, *$p \leq .01$ (two-tailed test). Convergence statistics: t ratios all < 0.07; Overall maximum convergence ratio < 0.21.
[a]Significant differences between classrooms. [b]To facilitate the interpretation of these network configurations, friendships are represented with solid lines and bullying relationships are represented with dashed lines.

Table 4.7 Results from longitudinal multivariate network models predicting co-evolution of friendship and bullying (14 classrooms, 352 students) – excluding the five classrooms with no optimal fit (3, 12, 13, 14, 17).

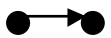
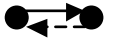
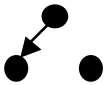
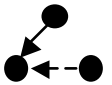
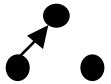
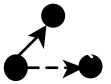
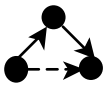
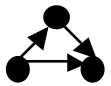
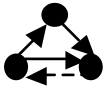
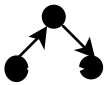
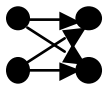
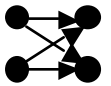
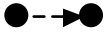
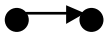
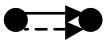
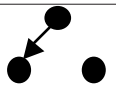
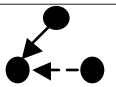
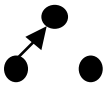
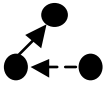
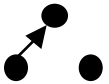
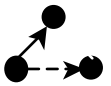
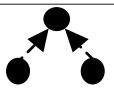
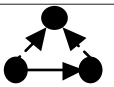
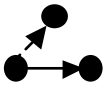
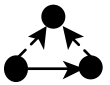
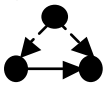
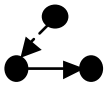
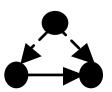
	Hypothetical change			Friendship networks			Bullying networks		
		→	tx + *m*	Est.	SE	n	Est.	SE	n
Effect parameters									
Rate effects									
Network rate t1→t2				8.21**	.58[a]	14	7.60**	1.35[a]	10
Network rate t2→t3				7.90**	.57[a]	14	6.06**	.49	10
Structure effects									
Outdegree (density)		→		-2.46**	.24	14	-1.98**	.25	14
Outdegree isolates		→					-1.46**	.36[a]	14
Indegree isolates		→					-2.22**	.28	13
Reciprocity		→		1.60**	.16	14	.38+	.22	13
Indegree popularity		→		.07	.07	14	-.008	.09	14
Outdegree activity		→		.02	.05	14	.09	.09	14
Transitive triplets		→		.25**	.09	14	.04	.15	14
Transitive reciprocated triplets		→		-.32**	.11	14			
Actors at distance 2		→		-.23**	.08	14	-.28+	.16	14
Four-cycles		→		-.03	.04	14	-.06	.07	14

Table 4.7 Continued

	Hypothetical change			Friendship networks			Bullying networks		
		→	tx + *m*	Est.	SE	n	Est.	SE	n
Sex effects									
Same sex		→		.63**	.14	14	.01	.16	14
Dyadic multiplex effects									
Existing tie W→ new tie X		→		-.35	.38	13	-.06	.30	13
Degree-related multiplex effects									
Indegree tie W→ Indegree tie X		→		-.006	.07	14	-.02	.07	14
Outdegree tie W → Indegree tie X		→		-.12	.11	14	.005	.11	14
Outdegree tie W → Outdegree tie X		→		-.01	.10	13	-.15+	.09	14
Mixed triadic multiplex effects[b]									
H1: shared victim to friendship		→		.42*	.18	14			
H2: friendship agreement to bullying		→					.74**	.16	14
H3: shared bully to friendship		→		.06	.11	13			
H4: friendship agreement to victimization		→					-.02	.14	13

Notes. Significance tests performed by dividing the estimates with its standard error resulting in *t*-Values which under the null hypothesis are approximately normally distributed (Ripley et al., 2019); +$p \leq .10$, *$p \leq .05$, *$p \leq .01$ (two-tailed test). Convergence statistics: t ratios all < 0.07; Overall maximum convergence ratio < 0.21. [a]Significant differences between classrooms. [b]To facilitate the interpretation of these network configurations, friendships are represented with solid lines and bullying relationships are represented with dashed lines.

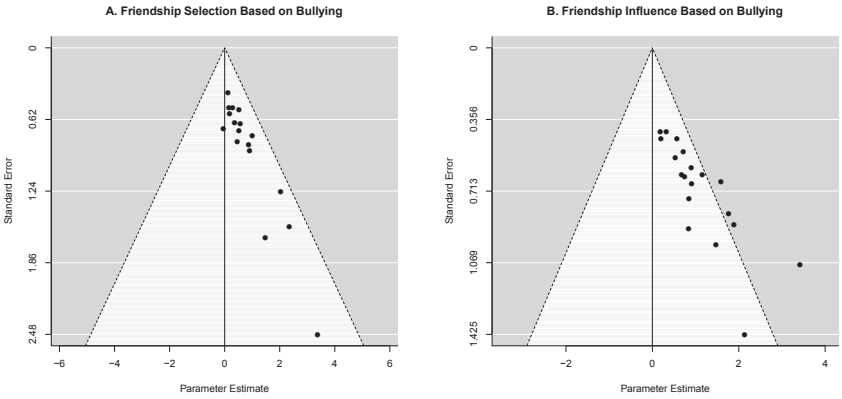


Figure 4.4 Distribution of estimates of bully selection (A) and influence (B) effects.

Dependencies between friendship and bullying or victimization were assessed in three ways (see part three in Table 4.5). Moran's *I* network autocorrelation coefficient indicates the degree to which friends are similar in bullying or victimization (Steglich et al., 2010). Values close to 0 are expected under random pairing (referring to perfect independence), whereas values close to 1 indicate perfect similarity. Typically, values of .2 to .3 indicate clear behavioral similarity. In our study, for most classrooms, the degree of similarity in bullying between friends was modest as indicated by positive, moderate values of Moran's *I* network autocorrelation coefficients (Steglich et al., 2010), whereas similarity in victimization was weak or absent. The amount of overlap between friendship and bullying was generally low meaning that friends did not bully each other. Finally, friendships occurred more among bullies with the same victims than among victims with the same bullies.

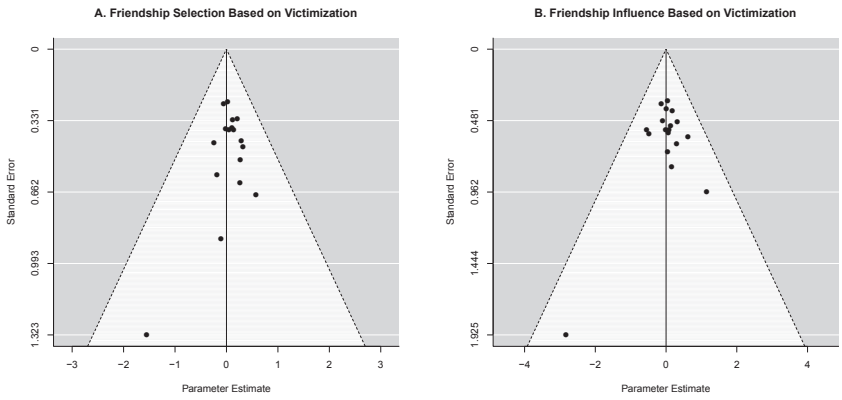


Figure 4.5 Distribution of estimates of victim selection (A) and influence (B) effects.

4.6.2 RSiena findings

Table 4.6 presents the summary of the multivariate RSiena analyses (performed with RSiena version 1.2-4). Figure S4.2 shows the results per classroom. The first column in Table 4.6 shows the mean estimates with friendships as the outcome, whereas the second column shows the mean estimates with bullying as the outcome. The results comprise two main parts: effects describing structural network dynamics for friendship and bullying separately; effects describing dynamics in dependencies between friendship and bullying.

Structural network effects

Participants were likely to be selective in their nominations (negative outdegree effects): they did not become friends with or bullied everyone (as indicated by the victims). Some students were uninvolved in bullying relationships: they were neither victimized (negative indegree isolate effect) nor bullied others (negative outdegree isolate effect). Nominations received were likely to be reciprocated (positive reciprocity effects). Furthermore, participants tended to nominate friends of friends as friends (positive transitive triplets effect) and to avoid having indirect connections (negative distance 2 effects). Friendships were often same sex, whereas bullying was directed to same- as well as cross-sex peers.

Between-networks effects: bully selection and influence hypotheses

These were tested by two between-networks effects (see Table 4.6; see also Fig. 4.1). Consistent with the bully selection hypothesis, the *shared victim to friendship* effects were positive in all classrooms (with the exception of one classroom; see Fig. 4.4 A with friendship as the outcome): when two children bullied the same victim they were likely to become friends (see Table 4.6: Est. = 0.41, $p < .05$). In line with the bully influence hypothesis, the *friendship agreement to bullying* effects were positive in all classrooms (see Fig. 4.4 B with bullying as the outcome): children were likely to start bullying the classmates who were bullied by their friends (see Table 4.6: Est. = 0.74, $p < .001$).

Between-networks effects: victim selection and influence hypotheses

These were tested by the matching between-networks effects in the opposite direction (see Table 4.6; see also Fig. 4.2). The victim selection hypothesis was not supported: the mean estimate of the *shared bully to friendship* effect was close to zero and non-significant (see Table 4.6: Est. = 0.06, $p = .53$). There was on average no indication that two children victimized by the same bully were likely to become friends (exceptions were found in three classrooms, see Fig. 4.5 A with friendship as the outcome). In addition, the victim influence hypothesis was not supported: the mean estimate of the *friendship agreement to victimization* effect was close to zero and non-significant (see Table 4.6: Est. = 0.03, $p = .81$). There was no indication that children were likely to become victimized by the bullies of their friends (with one exception,

see Fig. 4.5 B with bullying as the outcome).

4.7 Discussion

We examined the interplay between friendship and bullying ties in a sample of children in 19 elementary school classrooms over one year. Based on the idea that bullying is a group process, it was expected that friendships would be formed when two children bullied the same person (bully selection hypothesis) and that children would start to bully the victims of their friends (bully influence hypothesis). Similarly, it was expected that friendships would be formed when two children were victimized by the same bully (victim selection hypothesis) and that children would become victimized by the bullies of their friends (victim influence hypothesis). Longitudinal bivariate social network analysis provided evidence for the first two hypotheses, but not for the latter two.

4.7.1 Bully selection and influence

The finding that two children are likely to become friends when they bully the same classmate suggests that sharing a 'common target' promotes friendship. From a developmental perspective, friendships serve different functions and have different meanings for children across different stages of child development (Rubin, Bowker, McDonald, & Menzer, 2013; Rubin, Bukowski, & Parker, 2006), and based on this there may be several plausible explanations for this finding. In middle childhood, children describe their friends as those who are enjoyable and rewarding to be with. Like most other children, bullies also want social affection from their peers (Veenstra et al., 2010), and being in a friendship with someone that bullies the same victim might serve that specific purpose as these bullies are likely to be closer to each other and more in contact. Bullies may also have shared values about their own and other's bullying behavior, bullying attitudes, and morality, and this is central to children's conceptions of friendship, particularly because bullying behavior is considered as non-normative behavior. Accordingly, bullies might reward loyal peers and help them deal with others, for instance, by sticking up for them or becoming friends. A friendship might thus also protect from others who stand up to them by defending the victim, and secure a strong position in the group (Huitsing et al., 2014; Sainio et al., 2011), which may discourage others to side with the victim because of fear to become victims themselves (Pozzoli & Gini, 2010). Some children might also want to become friends with the bullies, particularly because bullies are often considered as popular among peers (Salmivalli, 2010; Veenstra et al., 2010). It is possible that these children try to become similar to the bullies are (in their attitudes, likes, and dislikes). One way to demonstrate similarity and to get the bullies' acceptance is to bully together with them. As a result, the friendship is formed, because the bullies like "joiners."

Our finding that children are likely to start to bully the same victims as their friends indicates that children 'agree' with their friends on whom to target. This may be explained by bullies influencing their friends on whom to victimize. Bullying is often associated with high social status (Salmivalli, 2010; Veenstra et al., 2010), and for that reason, children who are friends with bullies may conform to their behavior by joining in the bullying. This finding adds to our current understanding of bullying as a group process, by showing that friends play an important role in the bullying process. This is in line with previous research that shows that peers play a critical role in the development of bullying over and beyond child and family factors (Pepler, Jiang, Craig, & Connolly, 2008). It may provide behavioral confirmation, affection, and social status to the bullies, thereby forming a strong motivation to continue bullying (Salmivalli, 2010; Veenstra et al., 2010).

4.7.2 Victim selection and influence

Unlike previous network studies that found friendship selection and influence in victimization in adolescence (Lodder et al., 2016; Sentse et al., 2013; Sijtsema et al., 2013), our results did not provide evidence for the same processes in childhood. This may be explained by age or developmental differences. In our childhood sample, victimization was common as many children indicated being bullied by peers. In early adolescence, the number of bullies increases or remains stable, whereas the number of victims decreases (Nansel et al., 2001; Pellegrini & Long, 2002). This increase in bullying during early adolescence is followed by a decrease during mid- and late adolescence (Kretschmer et al., 2017). This suggests that victims are especially in a weak position in early adolescence when bullying peaks. It may also be that victims in childhood are not strategic enough to befriend co-victims, which may be a way to create social support and stop the bullying. Finally, children in elementary school have a history together. They know each other quite often since kindergarten. They often live in the same neighborhood where victims may still be connected to non-victims. However, in secondary education, the non-victims may no longer want to be associated with victims, as the importance of status increases. We note, however, that this explanation may not be generalizable outside the Netherlands, and this should be taken into account. For instance, in urban areas or large cities in the USA students may undergo multiple school transitions, from kindergarten to elementary school to middle or junior high school. In these situations, it is likely that children have less of a shared history together during elementary education.

4.7.3 Change in bully-victim networks

We noticed that the change in victim-bully ties is high (see also Huitsing et al., 2014; Rambaran et al., 2019a). Recent work on the dynamic interplay between bullying and popularity showed that bullies frequently change victims to maintain a high social status

(van der Ploeg et al., 2019). Apparently, repeatedly bullying the same victim loses its "effect" after some time, and bullies seek out new victims. This also underlines that bullies are goal-oriented and strategic (Salmivalli, 2010; Veenstra et al., 2010). It further points out that future research should incorporate the role of status or popularity as attributes of children when examining bullying in friendship networks.

4.7.4 Sex segregation friendship and bully-victim networks

Friendship networks were largely sex-segregated, whereas bullying was as often directed to same- as to cross-sex peers. Considerable work has demonstrated that children develop largely in segregated social worlds (Maccoby, 1998). Our findings suggest that excessive victim-bully relationships between the two sexes may be a reason for this: girls may not want to befriend boys because they may also be bullied by them, driving girls further apart from the boys in terms of friendship. This is in line with studies showing that boys and girls accept same-sex classmates over cross-sex classmates, and that boys are more often nominated than girls as bully perpetrators against both sexes, and that as a consequence boys who bully are rejected by girls for whom they pose a potential threat (Veenstra, Verlinden, Huitsing, Verhulst, & Tiemeier, 2013; Veenstra et al., 2010). Boys who bully may target girls, to maximize their gains in social status, while minimizing loss of affection or rejection from other bullying boys (Sainio, Veenstra, Huitsing, & Salmivalli, 2012). Compared to boys, girls who bully do so more relationally (e.g., social exclusion, gossiping; Espelage, Mebane, & Swearer, 2004), which makes it also less noticeable for other bullying girls who want to seek out their companion or friendship.

4.7.5 Limitations and directions for future research

Selecting stable classrooms greatly facilitated our examination of (peer) group processes in bullying and victimization, but many classrooms were left out from schools that combined one or more classes or grades. Most school children across the world are traditionally organized in same-age/grade classrooms (Mulyran-Kyne, 2007; Veenman, 1995), and our findings may only be applicable to these specific type of classrooms. However, there are also children who interact within mixed-age/grade peer groups as some schools combine different grades within one group, so-called multigrade or multi-age classrooms (Mulryan-Kyne, 2007; Veenman, 1995). Multigrade classrooms are prominent in the Netherlands. In our sample, only four schools in the control condition did not combine any classes or grades over the school year. These classrooms may exhibit different group dynamics (Ellis et al., 2012). For instance, bullying occurs more frequently within the same grade (Rambaran et al., 2019a, 2019d). Bullying is also not limited to classroom boundaries: they occur outside-of-classroom too (Huitsing et al., 2014). Hence, school-level or grade-level analyses would capture a larger proportion of children's bully-victim networks (Rambaran et al., 2019a).

Victims in similar positions may find friends in the wider school network.

Although our study included a broader definition of bullying relationships by including both bullying initiation and bullying assisting, we did not include bystanders in our analysis. Following the participant roles approach (Salmivalli et al., 1996), the behavior of bystanders in the classroom matters for the occurrence and continuation of bullying. For instance, with many defenders in the classroom, victims receive more support from peers (defending the victim) and the frequency of bullying is lower (Salmivalli, Voeten, & Poskiparta, 2011). In contrast, when there are many reinforcers of the bullies, the frequency of bullying is higher. This suggests that bullying relationships are affected by the classroom context in terms of group norms (Sentse, Scholte, Salmivalli, & Voeten, 2007). Moreover, children's positions in the classroom are also affected by their social status among peers, in terms of acceptance and rejection (Veenstra et al., 2010). A more comprehensive study of the group process of bullying would consider the role of bystanders, social status, and group norms.

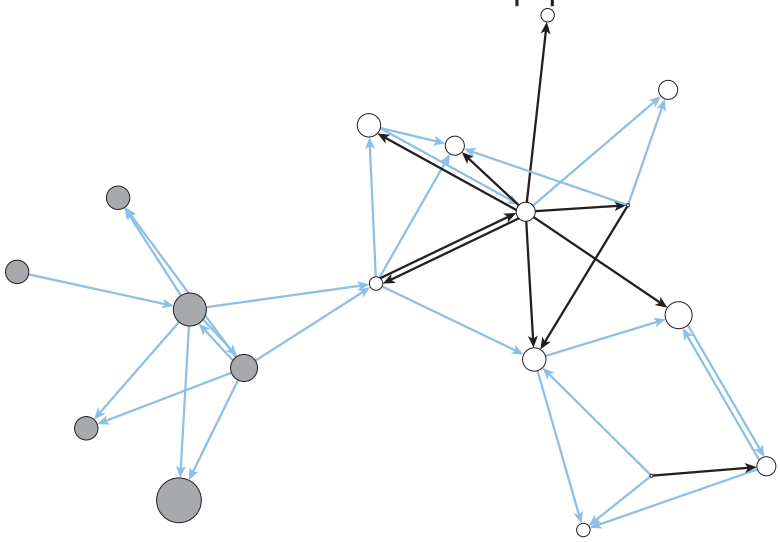
By incorporating a relational perspective to bullying, *who bullies whom*, we were able to test more subtle or intricate hypotheses concerning selection and influence processes resulting from the interplay between bullying relationships and friendship relationships. Even though we were able to link the bullying behavior of children to that of their friends, we do not know exactly *why* children (started to) bully their classmates, however. Similarly, we do not know precisely why bullies with the same victims befriended each other or why victims with the same bullies did not befriend each other. More detailed information about the specific reasons resulting in friendship selection and influence would allow for a better understanding of the mechanisms behind the group process of bullying.

4.7.6 Conclusion

Our study provides evidence for group processes in bully-victim networks in childhood. On the one hand, bullies are likely to select each other as friends; on the other hand, bullies are likely to influence their friends to start bullying. These novel findings highlight how group processes in bullying operate through children's peer networks in the classroom.

Chapter 5

The Relation between Defending, (Dis)liking and the Bullying Norm in the Classroom: A Multilevel Individual and Social Network Approach



This chapter is based upon:

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This study investigates the extent to which defending victims of bullying depends on liking and disliking, and its relation with classroom bullying norms. Two types of analyses were conducted in a sample of 1,272 grade 5 students (50.8% boys) in 48 classrooms. Multilevel Poisson regression analysis showed a positive relation between defending and liking nominations by victims, which was stronger in a classroom with a higher degree of bullying, with no additional effect of disliking, regardless of the classroom degree of bullying. Social network analysis (ERGMs) showed that children are more likely to defend victims whom they like, who like them, and who are liked by the same classmates than victims who they dislike, who dislike them, and with whom they share antipathies by and to the same classmates. In the ERGMs, the classroom degree of bullying had a negligible effect on the relation between defending and liking, while providing some evidence for a further reduction of the probability of children defending a victim they dislike. Both analyses provide support for generic hypotheses about associations between defending and (dis)liking, where the social network approach is able to test specific hypotheses distinguishing between direct affective relationships of defender and victim, and their shared relationships with classmates.

Keywords: social networks; defending victims; liking and disliking; bullying norms; childhood; multilevel modeling (Poisson regression); social network modeling (ERGMs)

5.1 Introduction

Research indicates that about 15% of school children bully others (Hong & Espelage, 2012), 30% are occasionally victimized, and another 10% are chronically victimized (Chester et al., 2015). Most children indicate that they do not approve of bullying and would like to help victims (Boulton et al., 2002; Rigby & Johnson, 2006; Rigby & Slee, 1991). Defending of victims is nevertheless relatively uncommon and many victims are not being defended (Salmivalli, 2010).

An explanation for why defending is relatively rare is that potential defenders may be discouraged to intervene because they fear to become a next victim (Pozzoli et al., 2012; Pozzoli & Gini, 2010), particularly in a classroom context where bullying is high (Meter & Card, 2015). In such a context, bullies often set the norm and are more liked and less disliked

by peers (Sentse et al., 2007). Moreover, children defend less in high bullying classrooms (Peets et al., 2015) and more in pro-victim classrooms (Yun & Graham, 2018).

Motivations for defending may also be shaped by interpersonal factors (Thornberg et al., 2012), such as being liked or disliked by the victim (Meter & Card, 2015). The findings of recent research using a social network approach suggest that children defend classmates with whom they are friends, but do not defend classmates who dislike them (Oldenburg et al., 2018). Thus, children are selective in choosing the victims they defend, and may be willing to accept the risk of being bullied when defending someone they are socially close to.

In order to assess defending and its relation with liking and disliking, one can use an individual approach and a social network approach. Defending can be seen both as individual behavior of children (student *i* defends others in general) and as a network relationship (student *i* defends a specific victim *j*, in network analysis often called the (directed) tie from actor *i* to actor *j*). In Study 1, we take an individual approach while accounting for the nested structure of the data and apply multilevel (Poisson) regression analysis to examine classroom defending behavior. More specifically, the analysis examines the extent to which the (relative) number of defending nominations depends on the (relative) number of liking and disliking nominations, and whether this relation varies with degree of classroom bullying. In multilevel analysis, statistical power is high because all classrooms are analyzed simultaneously. Moreover, individual effects can be separated from group effects to examine whether individual effects depend on group effects. The individual approach, however, uses individual-level measures, which are constructed from (network/tie level) peer nominations and thus violates the assumption of independence of observations within classrooms.

Moreover, by considering defending as an individual behavior, we lose information about the relational nature of defending (referring to *who defends whom*). Therefore, in Study 2, we examine defending networks using bivariate Exponential Random Graph Models (ERGMs) to examine their network structure and co-occurrence with like and dislike networks. This network approach enables the full use of the available information, acknowledging that (dis)liking and defending are relationships between two individuals which are embedded in larger social network configurations. Despite the many strengths of the network approach, available software permits the analysis of only two different types of classroom networks simultaneously (referring to defending and either liking or disliking). To combine the results of the ERGM analyses over classrooms, a meta-analysis has to be performed. As both the individual approach and network approach have their specific benefits and weaknesses, the aim of the paper is to investigate the differences in these two approaches with respect to their substantive findings, with a special interest for the effect of classroom bullying norms.

5.2 Theory

Bullying is typically defined as students are being bullied or victimized when they are exposed, repeatedly and over time, to negative actions on the part of one or more other students (Olweus, 1993, 1997). Recently, scholars have refined (the definition of) bullying as "aggressive goal-directed behavior that harms another individual within the context of a power imbalance" (Volk et al., 2014). This wording stresses a core aspect of bullying namely power imbalance: bullies target individuals in the group who are less able to defend themselves, with the strategic goal to enhance or maintain their own social status in the group. Targets of bullying are typically the individuals who are, or are perceived to be, physically, psychologically, or socially weaker than the bullies. Hence, to successfully intervene requires an equally or more powerful opponent to help the victims and to put a stop to the bullying (Peets et al., 2015). Students who do so are the defenders of victims, referring to defending as individual behavior or characteristic (Salmivalli, 2010).

5.2.1 Defending as individual behavior

Most studies focused on the individual characteristics associated with defending (for two recent reviews, see Meter & Card, 2015; Lambe, Cioppa, Hong, & Craig, 2019). Defending can be viewed as a special form of prosocial behavior because children who defend classmates behave in prosocial ways on behalf of victims (Meter & Card, 2015; Pronk et al., 2019). Affective empathy with victims (e.g., feeling sad for them) is linked to individual defending behavior (Lambe et al., 2019). Girls, who are generally higher in affective empathy than boys, defend more (Lambe et al., 2019), and older children, who typically possess a higher degree of self-efficacy, engage more in defending than younger children (Meter & Card, 2015). Defenders may also need sufficient self-confidence or self-esteem to stand up to the strong group position of bullies (Pöyhönen, Juvonen, & Salmivalli, 2010; Kollerová, Yanagida, Mazzone, Soukup, & Strohmeier, 2018). Defenders often enjoy a positive peer status: they are well-liked (Salmivalli et al., 1996; Pronk et al., 2017), not only by the victims who they defend, but by most peers, and are often perceived as popular among peers (Caravita, di Blasio, & Salmivalli, 2009; Peets et al., 2015; Pöyhönen et al., 2012). Defending behavior may also contribute to an increase in perceived popularity over time (van der Ploeg et al., 2017). In this perspective, victims are more likely to like those who defend them. This social position also enables defenders to challenge the bullies without running the risk of rejection, loss of status or affection (Pronk et al., 2017; van der Ploeg et al., 2017; Yun & Graham, 2018). Hence, social standing in the group plays an important role in defending behavior.

In this study, we focus on two important dimensions of children's social standing in the peer group: social liking and disliking (Cillessen & Marks, 2011). From an individual perspective, it

is to be expected that children who are socially well-liked by their classmates (both victims and non-victims) are also more able and willing to defend victims (Caravita et al., 2009; Kollerová et al., 2018; Salmivalli et al., 1996), whereas disliked children are less likely to be able to defend victims. So far, most bullying research examined defending and its antecedents as individual characteristics, thereby neglecting the relational aspects.

5.2.2 Defending as network

Researchers increasingly realize that defending can also be a network consisting of the ties between victims and their defenders. By examining defending as a network, researchers are able to investigate individual predictors of defending (similar to the individual approach), but it also allows researchers to investigate the effect of a (non-)friendly relationship between defender and victim and their relationships with other classmates (*who defends whom*).

Defenders are probably selective in choosing the victims they defend because there is a risk of being victimized as well (Huitsing et al., 2014). From a network or relational perspective, the decision to defend a victim may depend particularly on the strength or quality of the relationship with the victim (Lodge & Frydenberg, 2005; Pronk, Goossens, Olthof, de Mey, & Willemen, 2013). For instance, a defending relationship is more likely between friends who are willing to stand up for each other (Salmivalli et al., 1997; Oldenburg et al., 2018). In contrast, peers probably avoid defending victims who they dislike or who dislike them.

5.2.3 Bullying in a classroom context

It is well known that bullying situations occur mainly among classmates (Salmivalli, 2010). The classroom context most likely influences children's motivations and decisions for individual defending choices through peer group values and classroom norms (Meter & Card, 2015). For instance, defenders who think that most classmates will disapprove of their defending behavior may not intervene (Peets et al., 2015). With many bullies in their classroom, defenders may not even defend their friends because that puts them at risk for social consequences, such as low status, peer rejection, and even peer victimization. For instance, non-bullies were found to be more rejected and less liked by peers than bullies in classrooms where bullying is high (Sentse et al., 2007).

The amount or number of bullies in a classroom is indicative for the classroom context bullying norm. It reflects that bullying is considered as a "rule, value or standard" that is shared by most group members and that group members should follow the group's expectations regarding bullying such as having pro-bullying attitudes and engaging in bullying activities (Turner, 1991). The classroom norm may explain why peers witnessing bullying are more likely to intervene on behalf of the victim in some classrooms than in others (Salmivalli, 2010). It is

also possible, however, that in a classroom with more bullying, there are fewer non-bullies present to defend the victims of bullying. In this perspective, the lack of defending reflects a lack of availability of defenders rather than students' hesitancy to break the social norms.

5.3 The present study

We address the following questions: (1) What is the relation between (dis)liking and defending? (2) Does the classroom bullying norm facilitate or inhibit students' defending of victims? (3) Does the classroom bullying norm affect the relation between (dis)liking and defending? We answer these questions using two analytical approaches, an individual and a social network approach and compare the results obtained with these approaches.

In general, we expect to find a positive relation between defending and liking and a negative relation between defending and disliking. In addition, we expect that defending occurs less in classrooms where bullying is high, and that the positive relation between defending and liking is weakened, whereas the negative relation between defending and disliking is strengthened in such classrooms. For each method, we more specifically formulate our hypotheses (see Table 5.1 for an overview for both types of analyses).

5.3.1 Individual approach

In the multilevel Poisson regression analysis, we are able to distinguish between (dis) liking by victims and non-victims, leading to a set of more specific hypotheses: a stronger positive effect of *liking by victims* (H1a) than of *liking by non-victims* (H1b) on defending, and a stronger negative effect of *disliking by victims* (H2a) than of *disliking by non-victims* (H2b). We expect the positive effects of liking by victims (H3b) and non-victims (H3c) on defending to be weaker in a classroom where bullying is high, and the negative effects of disliking by victims (H3d) and non-victims (H3e) on defending to be stronger in high bullying classrooms.

5.3.2 Network approach

Using bivariate Exponential Random Graph Modeling (ERGM) allows us to examine the extent to which liking relations and disliking relations co-occur with defending relations, that is, whether a defender is (dis)liked by a victim and whether a victim is (dis)liked by a defender, and if so, whether this relation is (stronger) weaker in classrooms where bullying is high.

Victims may seek or receive help from classmates to whom they are directly positively connected, that is, who they like themselves (H1a2, Fig. 5.1 D.1) or by whom they are liked

Table 5.1 Overview of the hypotheses and effects used in the multilevel Poisson models and ERGM models.

	Multilevel analysis: Poisson regression (count data: the (relative) number of defending nominations a child receives from the victims in their classroom)[a]		Social network analysis: ERGMs (tie co-occurrence of liking and defending and disliking and defending among victims and their defenders)[b]	
	Hypothesis	Effect	Hypothesis	Effect
Direct relations				
Liking	H1a: The higher the number of liking nominations received from victims, the higher a student's number of defending nominations	Main effect: Liking by victims → Defending of victims	H1a1: A student is more likely to receive a defending nomination from a victim who likes him/her	ArcAB: Liking in-tie from victims → Defending in-tie from victims
			H1a2: A student is more likely to receive a defending nomination from a victim whom s/he likes	RecipAB: Liking out-tie to victims → Defending in-tie from victims
Disliking	H2a: The higher the number of disliking nominations received from victims, the lower a student's number of defending nominations	Main effect: Disliking by victims → Defending of victims	H2a1: A student is less likely to receive a defending nomination from a victim who dislikes him/her	ArcAB: Disliking in-tie from victims → Defending in-tie from victims
			H2a2: A student is less likely to receive a defending nomination from a victim whom s/he dislikes	RecipAB: Disliking out-tie to victims → Defending in-tie from victims
Indirect relations				
Liking	H1b: The higher the number of liking nominations received from non-victims, the higher a student's number of defending nominations	Main effect: Liking by non-victims → Defending of victims	H1b1: A student is more likely to receive a defending nomination from a victim if both are liked by the same classmate(s)	DKT-BAB: Closure of A for shared in-ties of B (like)
			H1b2: A student is more likely to receive a defending nomination from a victim if both like the same classmate(s)	UKT-BAB: Closure of A for shared out-ties of B (like)

Table 5.1 Continued.

	Multilevel analysis: Poisson regression (count data: the (relative) number of defending nominations a child receives from the victims in their classroom)[a]		Social network analysis: ERGMs (tie co-occurrence of liking and defending and disliking and defending among victims and their defenders)[b]	
	Hypothesis	Effect	Hypothesis	Effect
Disliking	H2b: The higher the number of disliking nominations received from non-victims, the lower a student's number of defending nominations	Main effect: Disliking by non-victims → Defending of victims	H2b1: A student is less likely to receive a defending nomination from a victim if both are disliked by the same classmate(s)	DKT-BAB: Closure of A for shared in-ties of B (dislike)
			H2b2: A student is less likely to receive a defending nomination from a victim if both dislike the same classmate(s)	UKT-BAB: Closure of A for shared out-ties of B (dislike)
Bullying norms[c]				
	H3a: The higher the bullying norm in a classroom, the lower the number of a student's defending nominations	Main effect: Classroom-level bullying → Defending of victims	H3a: The higher the bullying norm in a classroom, the lower the defending density in a classroom	Meta analysis: Main effect of bullying norm on ArcA (defending density)
Liking	H3b: The effect of liking from victims on a student's defending nominations is less strong in a classroom with a higher bullying norm	Cross-level interaction effect: Classroom-level bullying X Liking by victims → Defending of victims	H3b1: The higher the bullying norm in a classroom, the less likely it is that a student receives a defending nomination from a victim who likes him/her	Meta analysis: Main effect of bullying norm on ArcAB (Liking in-tie from victims → Defending in-tie from victims)
			H3b2: The higher the bullying norm in a classroom, the less likely it is that a student receives a defending nomination from a victim whom s/he likes	Meta analysis: Main effect of bullying norm on RecipAB (Liking out-tie to victims → Defending in-tie from victims)
	H3c: The effect of liking of non-victims on a student's defending nominations is less strong in a classroom with a higher bullying norm	Cross-level interaction effect: Classroom-level bullying X Liking by non-victims → Defending of victims	H3c1: The higher the bullying norm in a classroom, the less likely it is that a student receives a defending nomination from a victim whom is liked by the same classmate(s)	Meta analysis: Main effect of bullying norm on DKT-BAB (Closure of A for shared in-ties of B (like))
			H3c2: The higher the bullying norm in a classroom, the less likely it is that a student receives a defending nomination from a victim who likes the same classmate(s)	Meta-analysis: Main effect of bullying norm on UKT-BAB (Closure of A for shared out-ties of B (like))

Table 5.1 Continued.

	Multilevel analysis: Poisson regression (count data: the (relative) number of defending nominations a child receives from the victims in their classroom)[a]		Social network analysis: ERGMs (tie co-occurrence of liking and defending and disliking and defending among victims and their defenders)[b]	
	Hypothesis	Effect	Hypothesis	Effect
Disliking	H3d: The effect of disliking from victims on a student's defending nominations is more strong in a classroom with a higher bullying norm	Cross-level interaction effect: Classroom-level bullying X Disliking by victims → Defending of victims	H3d1: The higher the bullying norm in a classroom, the less likely it is that a student receives a defending nomination from a victim who dislikes him/her	Meta analysis: Main effect of bullying norm on ArcAB (Disliking in-tie from victims → Defending in-tie from victims)
			H3d2: The higher the bullying norm in a classroom, the less likely it is that a student receives a defending nomination from a victim whom s/he dislikes	Meta analysis: Main effect of bullying norm on RecipAB (Disliking out-tie to victims → Defending in-tie from victims)
	H3e: The effect of disliking of non-victims on defending nominations is more strong in a classroom with a higher bullying norm	Cross-level interaction effect: Classroom-level bullying X Disliking by non-victims → Defending of victims	H3e1: The higher the bullying norm in a classroom, the less likely it is that a student receives a defending nomination from a victim whom is disliked by the same classmate(s)	Meta analysis: Main effect of bullying norm on DKT-BAB (Closure of A for shared in-ties of B (dislike))
			H3e2: The higher the bullying norm in a classroom, the less likely it is that a student receives a defending nomination from a victim who dislikes the same classmate(s)	Meta-analysis: Main effect of bullying norm on UKT-BAB (Closure of A for shared out-ties of B (dislike))

Notes. [a]Distinction in liking and disliking between victims and non-victims is made by counting how many outgoing nominations are given by victims and non-victims (separate variables in the model). [b]A=defending tie from a victim to a defender; B=liking tie or disliking tie. [c]The operationalization of bullying norm is not unambiguously. Bullying norm was defined as the average degree of victims per classroom (referring to the average number of bullies nominated per victim). Note that this is different from what is typically used in bullying research, namely self-reports. Offset corrects for the number of victims (the maximum number of defending nominations) in the classroom.

(H1a1, Fig. 5.1 D.2). Mutual acquaintances may influence such a decision as well, for instance, when victims and their defenders like the same classmate (H1b1, Fig. 5.1 I.1) or are liked by the same classmate (H1b2, Fig. 5.1 I.2).

In contrast to liking, disliking is likely a reason for victims not to seek or receive help from classmates, *directly* (referring to disliking *of* a potential defender by a victim: H2a1, Fig. 5.1 D.1; and, disliking *by* a potential defender of a victim: H2a2, Fig. 5.1 D.2). Note that victims nominated their defenders, but liking and disliking ties could go both ways (from victims to defenders, or the other way around, from defenders to victims). The expectation about *indirect* (triadic) dislike relations (referring to disliking *by* the same person: H2b1, Fig. 5.1 I.1; and, disliking *of* the same person: H2b2, Fig. 5.1 I.2) are based on the consideration that students who dislike the same classmates or who are disliked by the same classmates are more likely to be friends (Rambaran et al., 2015), and for that reason are more likely to defend each other (Oldenburg et al., 2018). In classrooms where bullying is high, we expect fewer defending ties (H3a), weaker effects of liking (H3b and H3c), and stronger negative effects of disliking (H3d and H3e).

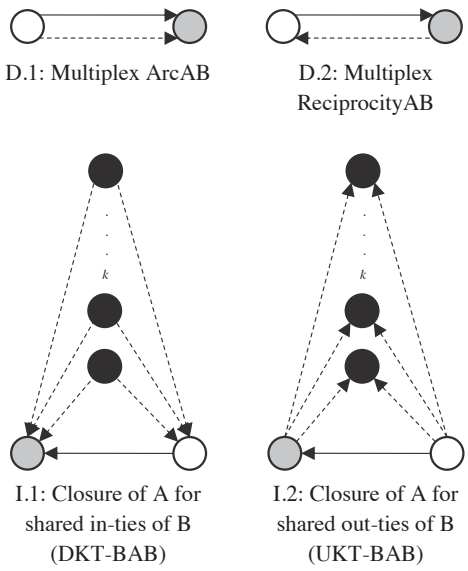


Figure 5.1 Direct (D.1-2, above) and indirect effects (I.1-2 below) of interplay between defending (solid lines, relations A) and (dis)liking (dashed lines, relations B) in two mirrored forms. D.1-2 and I.1-2 were included for both liking and disliking networks. The white circle represents a victim (referring to a student who could nominate a defender), the gray circle represents a nominated defender (by a victimized classmate), and the black circle represents another classmate.

5.4 Method

5.4.1 Sample

Classrooms were selected from the pre-assessment of the Dutch KiVa study at the end of the school year (in May 2012). KiVa is a program aimed to reduce school bullying among children in elementary education (8-12 years) in the Netherlands (Huitsing et al., 2019; Kaufman et al., 2018), originally developed in Finland (Kärnä et al., 2011, 2013). For this study, we selected the 48 grade 5 classrooms with at least 20 students yielding a total sample of 1,272 students (50.8% boy, *SD* = 9.1%; Mean age 11.25 years, *SD* = 0.46). Smaller classes are hard to compare to the more common larger classes and tend to carry less information which complicates the statistical social network analysis. With this procedure, we omitted the 25 smaller classes (referring to fewer than 20 students in the classroom) containing a total of 341 students. The students in the smaller classes received fewer defending nominations of classmates compared to the students in the larger classes (t = -9.36, $p < .001$). Moreover, compared to larger classes, smaller classes had fewer non-victims (t = -23.13, $p < .001$), fewer victims (t = -46.01, $p < .001$), and fewer bullies (t = -19.20, $p < .001$). All this can be related to classroom size. Relatively speaking, the proportion of defenders (t = 1.65, p = .10), non-victims (t = 0.91, p = .36), victims (t = -0.91, p = .36), and bullies (t = 0.72, p = .47) was similar in the smaller and the larger classes, and the proportion of boys as well (t = -.06, p = .95). A description of the program and the complete sample can be found in other studies (Huitsing et al., 2019; Kaufman et al., 2018).

5.4.2 Procedure

Students filled in an Internet-based questionnaire in their classroom during regular school hours. The process was administered by the teachers, who were present to answer questions and to assist the students when needed. Prior to the data collection, teachers were given detailed instructions concerning the procedure. During the data collection, support was available through phone and e-mail.

At the beginning of the questionnaire, students received information about the goal of the study, and how to fill in the questionnaire. They were told not to talk to each other or to discuss their answers when they filled out the questionnaire or afterwards to ensure each other's privacy. It was explained to students that their answers would remain confidential. The teachers ensured that students who could not complete the questionnaire at the day of the data collection participated at another day within a month.

Prior to the first measurement (and for students who were new in school, after the first measurement), schools sent information letters to students' parents. Parents who did not want their child to participate in the assessment were asked to return the form. Students were

informed at school about the research and gave oral assent. Students did not participate when parents refused participation, when they did not want to participate themselves, or when they were unable to complete the questionnaire. At the start of data collection (2012), universities in the Netherlands did not require IRB permission for this type of research. All procedures performed in this study were in accordance with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. A few students did not want to participate; also a few parents objected to their child's participation. The participation rate was high (98.3%).

In an instructional movie, a professional actress explained to students what bullying means, using the following text: "Bullying is when some children repeatedly harass another child. The child who gets bullied has problems defending itself against this. Bullying is not the same as having a fight between two people who are equally strong. Bullying should also not be confused with joking around. Bullying is treating someone repeatedly in a mean way." Several examples of bullying were given to students, including physical and material forms (e.g., hitting someone, kicking or pinching; stealing or damaging someone's belongings) and relational and verbal forms (e.g., making fun of someone, calling names, saying mean things; gossip about someone; excluding from social activities).

5.4.3 Measures

Following the general introduction, participants filled out nomination questions about the relationships with their classmates, using the accompanying text: "You and your classmates. The following questions concern how you and your classmates interact with each other. Answer the questions by selecting the names of your classmates." For each question, students were presented with a roster showing the names of all classmates on their personal computer screen. Participants could choose as many same-sex and other-sex classmates as they wished for each nomination question.

Liking and *disliking* were measured by asking participants to nominate the peers who they "liked the most" and "liked the least" in their classroom. Liking and disliking nominations were coded 1 and non-nominations were coded 0.

For *defending* we asked the victimized students to specifically nominate which classmate(s) defends them. To this end, defending was measured with network nominations for victims of bullying following a three-stage procedure. All participants were asked to indicate how often they were victimized in general in the past months ("Since the Christmas break"), according to Olweus' (1996) self-reported bully/victim items, and, to indicate this for specific form(s) of victimization; physical harm (e.g., kicked), verbal harm (e.g., name calling), relational harm (e.g., gossiping), and cyber victimization. Answers were given on a five

point scale: (1) "Not at all", (2) "Once or twice", (3) "Two or three times a month", (4) "Once a week", and (5) "Several times a week." If participants indicated that they were victimized by classmates at least "Once or twice" (score 2) on any item, they were presented with a roster showing the names of all classmates, and asked whom of their classmates defended them when they were being victimized: "Some children help children who are being bullied. They do this by supporting them, comforting them, or by telling the bullies to stop bullying. Are there children who support, comfort, or help you when you are being bullied?".

Bullying norms were measured with descriptive norms, referring to what is typically observed in a given situation or social context, and thus what most others do (Deutsch & Gerard, 1955; Cialdini, Reno, & Kallgren, 1990). Accordingly, this is measured using the average bullying behavior of all students in a classroom. In our study, bullying was measured with network nominations for peer victimization, by asking self-reported victims "Who of your classmates start bullying you?" The perception and experience of victims are important in bullying research. For that reason, we look at the classroom bullying norm from the point of view of the victim. Bullying nominations were measured as present (1) or absent (0). Bullying nominations sent by victims were summed and divided by the total number of victims in classroom, resulting in a continuous score ranging from 1 to 3.57 (mean = 2.23, *SD* = 0.66). The resulting score reflects the average number of bullies per victim (average degree). Table 5.2 shows an overview of the (distribution of) scores for each classroom.

5.5 Study 1: Method

5.5.1 Measures

Dependent variable

The sum of peer nominations received for *defending* (as sent by victims) for each student were summed, resulting in a score ranging from 0 to 11 (mean = 2.68, mean *SD* = 1.87).

Individual-level variables

The relative number of liking nominations received from victims and non-victims was calculated as proportions, resulting in a score for *liking by victims* ranging from 0 to 1 (mean = .40, *SD* = .18), and *liking by non-victims* ranging from 0 to 1 (mean = .47, *SD* = .24). In a similar way proportion scores for *disliking by victims* ranging from 0 to .71 (mean = .12, *SD* = .14), and for *disliking by non-victims* ranging from 0 to 1 (mean = .10, *SD* = .15) were obtained. In addition, *sex* (1 = boy) and *bully status* (1 = bully; referring to students who received at least one bully nomination of self-reported victims) were included.

Table 5.2 Overview of the classroom norms of bullying in this study.

Class	Class size	Defending distribution			Bullying/victimization distribution		
Id	Total students	Total defenders[a]	Mean defending[b]	Variance defending	Total Victims[c]	Total Bullies[d]	Bully Norm[e]
1	31	25	1.77	1.51	20	12	3.00
2	22	13	1.91	3.90	14	11	3.57
3	32	31	2.28	2.60	17	11	2.67
4	31	27	2.26	3.13	24	15	2.12
5	22	20	1.82	0.73	13	4	1.50
6	30	25	1.70	1.25	16	5	2.25
7	25	24	3.84	4.39	20	12	3.56
8	24	23	3.33	2.58	19	8	2.14
9	22	21	2.59	1.78	17	6	1.25
10	26	24	1.81	1.04	17	5	1.00
11	24	24	2.75	1.07	17	11	2.43
12	23	18	1.65	1.51	14	11	2.57
13	23	23	2.78	1.72	13	10	3.25
14	29	26	2.55	2.97	24	17	2.90
15	36	33	2.44	3.00	27	14	2.18
16	36	36	3.47	2.54	30	15	2.27
17	26	22	1.92	1.91	22	13	2.73
18	20	18	3.55	6.26	17	13	2.38
19	26	25	3.35	2.80	20	10	2.46
20	22	22	3.00	1.05	15	7	2.50
21	23	21	3.00	2.73	15	12	2.57
22	23	19	1.78	1.63	14	8	1.71
23	24	24	4.04	2.56	16	7	1.33
24	27	20	1.26	1.05	17	6	2.00
25	30	28	2.30	2.49	21	6	1.25
26	26	24	2.35	2.88	19	12	2.13
27	24	20	2.83	4.41	19	7	1.40
28	27	27	2.59	2.25	16	8	1.71
29	27	23	2.44	2.41	23	14	3.08
30	28	24	2.64	3.20	18	7	1.67
31	25	24	3.32	3.81	18	13	2.43
32	27	26	2.70	2.06	9	3	1.50
33	24	20	2.50	4.87	13	7	2.40
34	30	28	2.97	2.93	23	9	1.86

Table 5.2 Continued.

Class	Class size	Defending distribution			Bullying/victimization distribution		
Id	Total students	Total defenders[a]	Mean defending[b]	Variance defending	Total Victims[c]	Total Bullies[d]	Bully Norm[e]
35	27	17	1.22	1.49	13	9	2.00
36	25	24	4.28	4.54	22	11	2.60
37	31	28	2.65	3.17	23	3	1.00
38	23	23	5.52	4.99	20	8	2.09
39	28	27	3.61	3.65	24	13	2.33
40	29	25	4.14	7.69	20	14	2.80
41	28	26	2.64	3.87	22	13	2.44
42	26	20	1.46	1.46	19	8	1.64
43	26	26	4.81	5.68	21	16	3.31
44	25	24	3.04	3.04	19	9	2.43
45	27	25	2.70	2.14	18	16	3.40
46	26	15	0.92	1.11	14	9	1.60
47	25	23	2.60	2.83	17	9	2.00
48	31	27	2.16	2.27	19	9	1.40
Mean	26.50	23.71	2.69	2.81	18.50	9.92	2.23
SD	3.51	4.21	0.93	1.47	4.05	3.54	0.66

Notes. [a]Number of students in classroom who received at least one defending nomination from other classmates (indegrees for the question "Who defends you when you are bullied?"). [b]Only victims (see under [c]) could send defending nominations in this study. [c]Number of students in classroom who indicated being victimized based on the Olweus' (1996) self-reported bully/victim items, including the specific forms (i.e., physical harm, verbal harm, relational harm, and cybervictimization) on a five point scale: (1) "Not at all", (2) "Once or twice", (3) "Two or three times a month", (4) "Once a week", and (5) "Several times a week." Students who indicated being victimized by classmates at least "Once or twice" in the past months ("Since the Christmas break"), received the additional defending nomination question. [d]Number of students who received at least one bullying initiation nomination from other classmates (indegrees for the question "Who starts bullying you?"). [e]Calculated as the average number of bullying initiation nominations send by victims to classmates (total number of outdegrees for the question "Who starts bullying you?" divided by the number of nominators).

Classroom-level variables

Classroom-level variables corresponding to the individual-level variables were computed. The variables *liking by victims* (range = .22 to .63, mean = .40, *SD* = .10) and *liking by non-victims* (range = .25 to .85, mean = .47, *SD* = .13), as well as the variables *disliking by victims* (range = .04 to .22, mean = .12, *SD* = .05) and *disliking by non-victims* (range = 0 to .24, mean = .10, *SD* = .05), were used in the analysis. The proportion of boys (*average sex*) in classroom ranging from .32 to .77 (mean = .51, *SD* = .09) was computed as well. The bullying norm is calculated as the number of bullies per victim in classroom.

5.6 Study 1: Analytic strategy

Multilevel Poisson regression analysis (see e.g., Cameron & Trivedi, 2003) was employed using the R-package mle4 glmer function (Bates, Mächler, Bolker, & Walker, 2015) to handle the discrete non-negative character of the outcome variable: the number of received defending nominations. Defending nominations were sent only by the victims (see Measures), and the number of victims varied between classrooms (see Table 5.2). To this end, we used the number of victims in classroom as an offset to account for opportunity differences in receiving defending nominations, thus modeling the rate of defending.

Sex, bully status, non-victim status, number of liking nominations received (from victims and non-victims), and number of disliking nominations received (from victims and non-victims) served as within-classroom individual-level covariates (all group-mean centered). The number of liking and disliking nominations received from non-victims can be viewed as student's general status regarding liking and disliking by peers in the classroom. Average sex (proportion of boys) in classroom and bullying norm (the average number of bullies per victim) served as the classroom-level covariates. To facilitate interpretation, these variables were grand-mean centered. Table 5.3 describes the individual-level and classroom-level variables (range and sex differences) and Table 5.4 displays the correlations between these study variables.

To test the hypotheses, we estimated a sequence of three models, separately for liking and disliking (to avoid multicollinearity issues as shown by a collinearity diagnostics test): a model with all individual effects to test hypotheses about effects of liking or disliking by victims (H1a, *liking by victims*, and H2a, *disliking by victims*), and non-victims (H1b, *liking by non-victims*, and H2b, *disliking by non-victims*) on defending nominations received; a model with all classroom effects including the main effect of bullying norms on defending nominations (H3a), and a model with an additional interaction term between bullying norms and each hypothesized effect (H3b, *liking by victims*; H3c, *liking by non-victims*; H3d, *disliking by victims*; and, H3e, *disliking by non-victims*). All models included sex, non-victim status, and bully status as individual covariates; the models with classroom-level variables included also the proportion of boys. A final model was obtained after performing a backwise selection procedure starting from a complete model including all previously mentioned variables.

5.7 Study 1: Results

5.7.1 Descriptive analysis

We calculated the distribution of number of defending nominations students received from victims in each classroom (see Figure 5.2). Although defending nominations were observed in each classroom, the number of defending nominations varies greatly within and between classrooms (see Figure 5.2). On average, students received 2.68 (*SD* = 1.87) defending nominations from their victimized classmates, see Table 5.3. Put differently, on average students defended close to three different victims in their classroom. Compared

Table 5.3 Description of the variables used in this study.

	Range (min-max)	Mean	SD	Mean girls	Mean boys
Individual-level variables					
Sex (1=boy)	0-1	0.51			
Defending[a]	0-11	2.68	1.87	2.86	2.50
Victimization[b]	0-13	0.79	1.53	0.90	0.69
Non-victim status[c]	0-1	0.66		0.62	0.69
Bully status[d]	0-1	0.37		0.26	0.48
Liking by victims[e]	0-1	0.40	0.18	0.41	0.39
Liking by non-victims[e]	0-1	0.47	0.24	0.47	0.46
Disliking by victims[e]	0-0.71	0.12	0.14	0.10	0.15
Disliking by non-victims[e]	0-1	0.10	0.15	0.088	0.11
Classroom-level variables					
Av. sex	0.32-0.77	0.51	0.090		
Av. defending	0.92-5.52	2.69	0.93	2.81	2.51
No. of victims[f]	9-30	18.5	4.05	9.15	9.35
No of non-victims[f]	3-18	8.00	3.26	3.94	4.06
Av. liking by victims	0.22-0.63	0.40	0.10	0.41	0.39
Av. liking by non-victims	0.25-0.85	0.47	0.13	0.47	0.47
Av. disliking by victims	0.041-0.22	0.12	0.05	0.10	0.15
Av. disliking by non-victims	0-0.24	0.098	0.053	0.087	0.11
Bullying norm[g]	1-3.57	2.23	0.66	2.29	2.14

Notes. $N_{individuals}$=1,272 students (628 girls, 644 boys); $N_{classrooms}$=48 classrooms (Grade 5). [a]Defending was measured as the total number of defending nominations received from self-reported victims. [b]Victimization was measured as the total number of bully nominations sent by self-reported victims. [c]Non-victim status was measured as having self-reported to not being victimized. [d]Bully status was measured as having received at least one bully nomination of a victim. [e]Measured as the average degree of nominations received from victims or non-victims (referring to total number of nominations received divided by the total number of self-reported victims or non-victims in classroom). [f]Measured as the total number of children in classroom who indicated being victimized (self-reported victims) or who did not indicate being victimized (self-reported non-victims). [g]Bullying norm was defined as the average degree of victims per classroom (referring to average number of bullies nominated per victim).

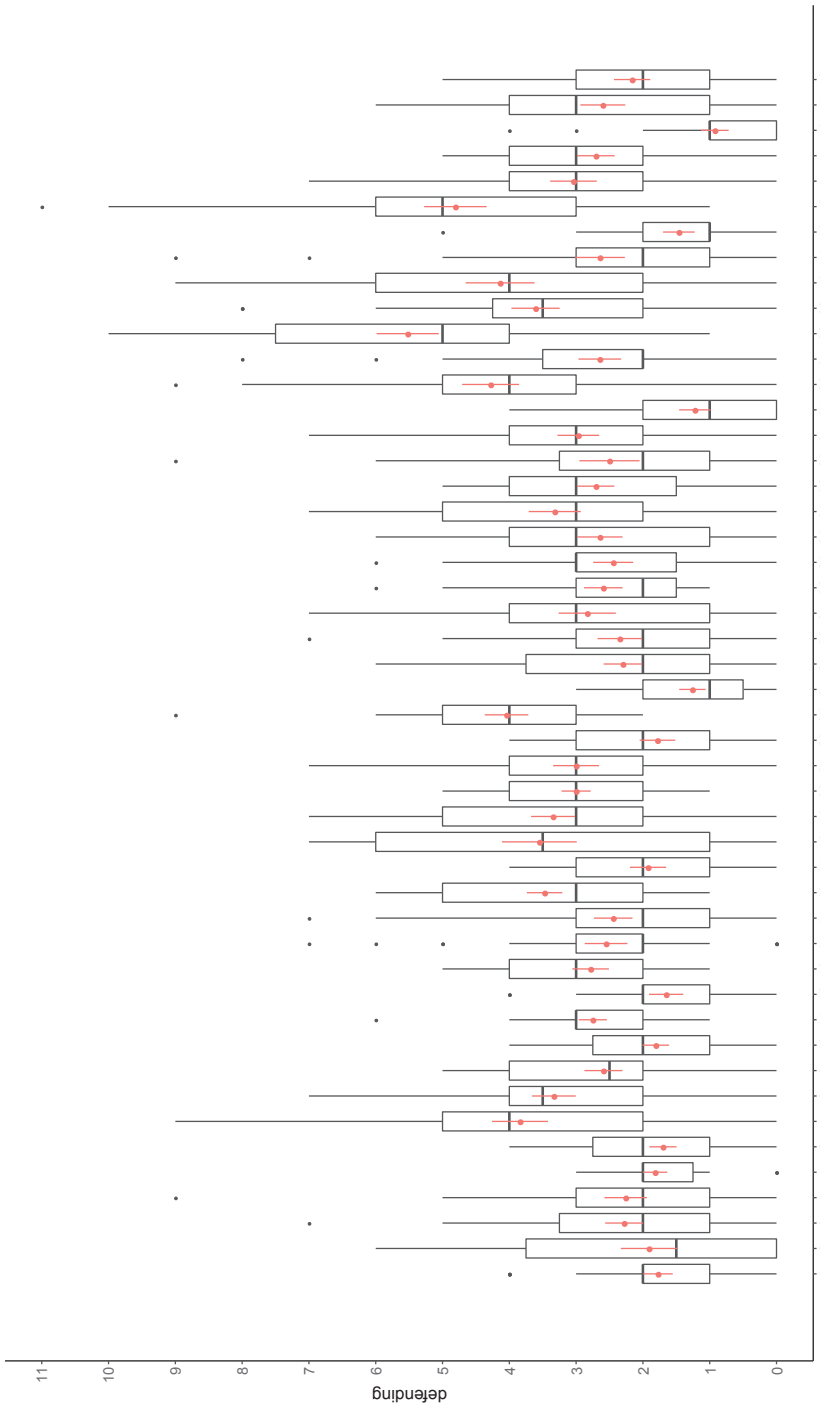


Figure 5.2 Distribution of defending nominations per classroom. The mean (and 95% confidence intervals) of defending nominations in classroom is shown within each boxplot (the boxplot itself shows the median). This figure was created in R using ggplot2 (Wickham, 2016).

to boys (mean 2.50), girls (mean 2.86) received more defending nominations of the victims ($t = 3.38$, $p < .001$) and victimized girls sent more bullying nominations to other classmates than did victimized boys (mean boys 0.69, mean girls 0.90; $t = 2.45$, $p = .015$). The classrooms had, on average, 2.23 bullies per victim (as reported by victims), with a minimum of 1, and a maximum of 3.57.

Table 5.4 shows the bivariate correlations among the study variables at the individual level, which are comparable in size for boys and girls. Students who received more defending nominations from victims received also more liking nominations ($r_{girls} = .48$ and $r_{boys} = .42$) and fewer disliking nominations ($r_{girls} = -.28$, and $r_{boys} = -.20$). In classrooms with more non-victims (fewer victims), both the mean number of bullying and defending nominations received from victims tended to be lower ($r = -.23$ and $-.53$).

Table 5.4 Correlations between the variables used in this study.

Individual-level variables	1	2	3	4	5	6	7
1 Defending	--	.01	.09*	.42**	.20**	-.20**	-.21**
2 Non-victim status	.05	--	-.08*	.11*	.01	-.13*	-.07
3 Bully status	-.02	-.02	--	-.13*	-.03	.33**	.15**
4 Liking by victims	.48**	.15**	-.07	--	.50**	-.64**	-.49**
5 Liking by non-victims	.24**	.00	-.05	.47**	--	-.40**	-.51**
6 Disliking by victims	-.28**	-.19**	.20**	-.56**	-.40**	--	.61**
7 Disliking by non-victims	-.20**	-.21**	.13**	-.36**	-.45**	.60**	--
Classroom-level variables	**8**	**9**	**10**	**11**	**12**	**13**	**14**
8 Av. defending	--						
9 No. of non-victims	-.53**	--					
10 Av. sex	-.07	-.17	--				
11 Av. liking by victims	.22	-.02	-.05	--			
12 Av. liking by non-victims	.17	-.08	.04	.60**	--		
13 Av. disliking by victims	.17	-.21	-.09	-.36*	-.22	--	
14 Av. disliking by non-victims	.08	-.10	-.15	-.29*	-.35*	.44**	--
15 Bullying norm	.25	-.23	-.16	.07	.13	.35*	.05

Notes. $N_{individuals}$=1,272 students (628 girls, 644 boys); $N_{classrooms}$=48 classrooms (Grade 5). See Table 5.1 for an explanation on how the different variables in this table were constructed. Correlations below the diagonal for girls; above the diagonal for boys. *$p \leq .05$, **$p \leq .01$ (two-tailed test).

5.7.2 Multilevel analysis: defending and liking

Model 1 in Table 5.5 displays the parameter estimates of the multilevel Poisson regression analysis of the individual-level effects for liking (without any classroom-level or cross-level effects). The intercept of Model 1 in Table 5.5 represents the mean (estimated) log of students' defending rate (for all other variables equal to zero, referring to non-bullying girls who did not receive any liking nomination from victims or non-victims): *exp*(-1.985)

= 0.14. With an estimated standard deviation of 0.31 (√ 0.10), this defending rate varies between *exp*(-2.601) = 0.07 and *exp*(-1.369) = 0.25 over classrooms. Boys were defending at 11 percent lower rate than girls (*exp*(-0.122) = 0.89, $p < .001$), and bullies were defending at 14 percent higher rate than non-bullies (*exp*(0.128) = 1.14, $p < .001$).

Individual-level effects

Model 1 in Table 5.5 provides parameter estimates consistent with the hypothesized effect of liking by victims on defending. As expected, the defending rate is approximately 11 times higher when the (potential) defender is being liked by all victims in the classroom compared to when he or she is not being liked by any of the victims (H1a, *exp*(2.382) = 10.83, $p < .001$). No evidence was found for the hypothesized effect of liking by non-victims on defending (H1b), that is, in addition to the effect of liking by victims.

Classroom-level effects

Model 2 in Table 5.5 displays the parameter estimates of the multilevel Poisson regression analysis with all classroom-level effects. Model 2 can be used to investigate whether the within-group (individual) and between-group (classroom) estimates differ for liking by victims and non-victims (see Snijders & Bosker, 2012, Section 4.6). The classroom-level effects of liking indicate that defending increases (non-significantly) in classrooms with high average classroom liking by victims (maximally by a factor equal to *exp*(0.730) = 2.08, $p = .18$) and liking by non-victims (maximally by a factor equal to *exp*(0.418) = 1.52, $p = .32$). The small and non-significant effect of bullying norm provides no support for hypothesis H3a, providing no evidence for less defending in classrooms with more bullying.

Cross-level interactions

Models 3a and 3b in Table 5.5 contain individual-level and classroom-level variables as well as cross-level interactions. Classroom descriptive norms regarding bullying moderated the effect of *liking by victims* on the defending rate, but not in the expected direction (H3b). The positive relation between liking by victims and defending rate increased rather than decreased in a classroom with a higher degree of bullying (Model 3a in Table 5.5: *Bullying norm X liking by victims*, *exp*(0.431) = 1.54, $p < .05$). The findings did not indicate that classroom norms of bullying moderated the relation between defending rate and *liking by non-victims* (H3c).

5.7.3 Multilevel analysis: defending and disliking

Models 4 to 6 in Table 5.5 contain the parameter estimates for all individual-level and classroom-level effects, and cross-level interactions for disliking.

Table 5.5 Multilevel Poisson models – defending nominations as dependent variable (rates of defending nominations), and liking, disliking, and bullying norms as explanatory variables.

	Defending and liking								Defending, liking, and disliking	
	Model 1: Individual		Model 2: Classroom		Model 3a: Interaction		Model 3b: Interaction		Model 7: Final model	
	Est.	SE	Est.	SE	Est.	SE	Est.	SE	Est.	SE
Intercept (defending rate)[a]	-1.985*	.058	-1.991*	.065	-2.003*	.065	-1.995*	.065	-1.999*	.056
Individual-level predictors										
Sex (1=boy)	-.122*	.036	-.118*	.036	-.110*	.036	-.118*	.036	-.112*	.036
Non-victim (1=non-victim)	-.031	.038	-.029	.038	-.031	.038	-.027	.038		
Bully (1=bully)	.128*	.038	.124*	.038	.127*	.038	.125*	.038	.132*	.038
Liking by victims	2.382*	.136	2.370*	.136	2.506*	.148	2.380*	.136	2.428*	.149
Liking by non-victims	.008	.095	.012	.095	.018	.095	.068	.103		
Disliking by non-victims									-.171	.153
Classroom-level predictors										
Av. sex			-.529	.517	-.554	.518	-.529	.516	-.479	.519
Av. liking by victims			.730	.553	.729	.554	.733	.552	1.068*	.451
Av. liking by non-victims			.418	.420	.420	.421	.419	.420		
Bullying norm[b]			.033	.070	.011	.071	.027	.071	.022	.071
Cross-level interactions										
Bullying norm X liking by victims					.431*	.185			.418*	.185
Bullying norm X liking by non-victims							.211	.148		
Model fit statistics[b]										
Deviance	4434.9		4425.7		4420.2		4423.6		4420.7	
X^2 (df)	395.8 (5)		7.7 (4)		5.4 (1)		2.0 (1)		--	
Random effects										
Variance	.1005		.0814		.0820		.0813		.0837	

Table 5.5 Continued.

	Defending and disliking							
	Model 4: Individual		Model 5: Classroom		Model 6a: Interaction		Model 6b: Interaction	
	Est.	SE	Est.	SE	Est.	SE	Est.	SE
Intercept (defending rate)[a]	-2.023*	.059	-2.040*	.067	-2.043*	.067	-2.040*	.067
Individual-level predictors								
Sex (1=boy)	-.084*	.036	-.080*	.036	-.078*	.037	-.081*	.036
Non-victim (1=non-victim)	.035	.038	.034	.038	.034	.038	.034	.038
Bully (1=bully)	.142*	.039	.140*	.039	.140*	.039	.140*	.039
Disliking by victims	-1.541*	.195	-1.544*	.195	-1.588*	.206	-1.543*	.195
Disliking by non-victims	-.522*	.164	-.525*	.165	-.522*	.165	-.540*	.173
Classroom-level predictors								
Av. sex			-.646	.547	-.646	.547	-.645	.547
Av. disliking by victims			-1.013	1.208	-1.011	1.208	-1.013	1.208
Av. disliking by non-victims			-.790	1.016	-.788	1.016	-.789	1.016
Bullying norm[b]			.078	.079	.074	.079	.077	.079
Cross-level interactions								
Bullying norm X disliking by victims					-.172	.256		
Bullying norm X disliking by non-victims							-.064	.228
Model fit statistics[b]								
Deviance	4651.1		4647.7		4647.3		4647.6	
X^2 (df)	177.4 (5)		4.0 (4)		.4 (1)		.1 (1)	
Random effects								
Variance	.0994		.0922		.0923		.0921	

Notes. [a]Offset corrects for the number of victims (the maximum number of possible defender nominations) in the classroom. All individual-level predictors were group-mean centered and all classroom-level predictors were grand-mean centered before entering the multilevel equations. See Table 5.3 for an explanation on how the different variables in this table were constructed. [b]Model comparisons were done using ANOVA tests: Model 1 (4) vs. "empty model" Model 0 (only defending rate); Model 2 (5) vs. Model 1 (4); Model 3 (6) vs. Model 2 (5). $+p \leq .10$, $*p \leq .05$ (two-tailed test).

Individual-level effects

The intercept of Model 4 in Table 5.5 represents the mean (estimated) log of students' defending rate (for all other variables equal to zero, referring to non-bullying girls who did not receive any disliking nomination from victims or non-victims): *exp*(-2.023) = 0.13. With an estimated standard deviation of 0.32 (√ 0.10), this defending rate varies between *exp*(-2.645) = 0.07 and *exp*(-1.401) = 0.25 over classrooms. As expected, the defending rate is (more than) halved when the (potential) defender is being disliked by all victims (or non-victims) in the classroom compared to when he or she is not being disliked by any of the victims (H1b, *exp*(-1.541) = 0.21, $p < .001$) or non-victims (H2b, *exp*(-0.522) = 0.59, $p < .001$).

Classroom-level effects

Model 5 in Table 5.5 shows that the classroom-level parameter estimates of disliking are smaller than those of liking and, again, not significant. The parameter estimate of the bullying norm is slightly larger, but, again, not significant.

Cross-level interactions

Models 6a and 6b do not indicate that classroom norms of bullying moderated the relation between defending rate and *disliking by victims* (H3d) or *disliking by non-victims* (H3e).

5.7.4 Multilevel analysis: defending, liking, and disliking

Finally, Model 7 in Table 5.5 contains the remaining variables in the model after a backward selection procedure of all earlier used variables. The resulting model resembles Model 3a most, containing mostly liking variables. The "best" variable pertaining to disliking was included in the model as well, which indicated a relatively small and non-significant effect of individual disliking by non-victims.

5.8 Study 2: Method

5.8.1 Measures

Dependent variables: liking, disliking, and defending networks

For each classroom, these were based on directed "Who do you like?", "Who do you dislike?", and "Who defends you when you are bullied?" nominations (1 for present and 0 for absent). Children who indicated not being victimized by classmates did not fill out the nomination question on defending. Their "answers" were considered as "structural missing" (no outgoing nomination possible).

Explanatory variables
As in study 1, we included *sex* (1 = boy) and *bullying norms*.

5.9 Study 2: Analytic strategy

Bivariate Exponential Random Graph Models (ERGMs; Lusher et al., 2013) were estimated in XPNet (Wang et al., 2009) to investigate the patterns of the defending, liking and disliking networks. Because the software cannot handle more than two dependent networks, the analysis is split into a separate model for defending and liking; and, a separate model for defending and disliking.

To test the hypotheses, four multiplex configurations (see Figure 5.1) were included in the models for defending and (dis)liking, referring to configurations capturing the (lack of) co-occurrence of two different network ties between two or more actors in the network. Direct effects of co-occurrence of defending and (dis)liking were captured using two dyadic multiplex configurations: victims who (dis)like their defenders (D.1); defenders who (dis)like the victims they defend (D.2). Indirect effects of co-occurrence of (dis)liking and defending were captured using two types of triadic configurations: a victim and the defenders who are both (dis)liked by the same other person (I.1); and, a victim and the defenders who both (dis)like the same other person (I.2).

To adequately capture other structural features of the defending, liking, and disliking networks, we followed previous studies in choosing the parameters in bivariate Exponential Random Graph Models (Oldenburg et al., 2018; Huitsing et al., 2012; Huitsing & Monks, 2018; Huitsing & Veenstra, 2012). Moreover, sex was included not only as an individual covariate expressing differences in the tendencies of boys and girls in defending and (dis)liking, but also as a dyadic (network) covariate, capturing tendencies for establishing same-sex ties (cross-sex ties as reference). Three other dyadic (network) covariates were included as control variables to account for bullies to be nominated as defender by their victims, and for victims to like or dislike their defenders (in the models where they were not included as a network), and for students to like those they dislike or vice versa.

For each of the two bivariate analyses, a model was estimated per classroom with the same specification (see Table 5.6 for an overview). For some classrooms, however, model parameters were left out, because the models could not be estimated because of lack of information or lack of convergence for one or more parameters (see Table S5.1 in the Supplements). For the converged models, the usual criterion for convergence (absolute

Table 5.6 Overview of the univariate and multivariate parameters in the bivariate exponential random graph models (ERGMs).

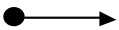
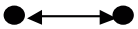
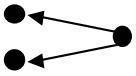
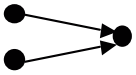
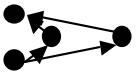
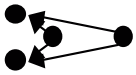
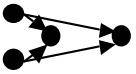
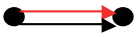
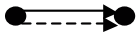
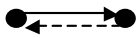
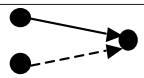
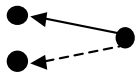
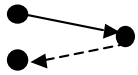
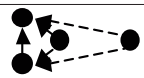
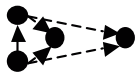
Parameter (statistic)		Interpretation	Illustration
Univariate parameters			
Dyadic parameters			
1	Density (Arc)	Occurrence of ties	
2	Reciprocity	Occurrence of mutual ties	
Degree-level parameters[a]			
3	Sinks	Occurrence of actors with zero outdegree and at least one indegree	
4	Sources	Occurrence of actors with zero indegree and at least one outdegree	
5	Isolates	Occurrence of isolated actors (zero indegree and zero outdegree)	
6	In-2-stars	Dispersion of in-ties distribution, with some actors receiving more nominations than others (structural equivalence)	
7	Out-2-stars	Dispersion of out-ties distribution, with some actors giving more nominations than others (structural equivalence)	
Multiple connectivity and closure parameters[b]			
8	Multiple two-paths (A2P-T)	Occurrence of (multiple) out-ties and in-ties; actors who are connected at distance two (indirect connections)	
9	Shared in-ties (A2P-D)	Structural equivalence with regard to in-ties; actors who are nominated by the same other person	
10	Shared out-ties (A2P-U)	Structural equivalence with regard to out-ties; actors who give nominations to the same other person	
Binary covariate parameters			
11	Sex (1=boy) receiver[c]	Boys receive more nominations than girls	
Network covariate parameters			
12	Same sex[c]	Girls send nominations to girls; boys send nominations to boys	
13	Bully	Occurrence of victims nominating their bullies as either defender, like or dislike	
14	Like	Occurrence of students nominating those they like as either defender or dislike	
15	Dislike	Occurrence of students nominating those they dislike as either defender or like	

Table 5.6 Continued.

Parameter (statistic)		Interpretation	Illustration
Multivariate parameters[d]			
Dyadic parameters			
16	Multiplex ArcAB	Occurrence of nominating others for both A and B	
17	Multiplex ReciprocityAB	Occurrence of nominating others for A and receiving nominations for B	
Mixed dyadic parameters[b]			
18	In2StarAB	Actors with in-ties for A and B	
19	Out2StarAB	Actors with out-ties for A and B	
20	Mixed2StarAB	Actors with in-ties for A and out-ties for B	
Triadic multiple connectivity and closure parameters[d]			
21	Closure of A for shared in-ties of B (DKT-BAB)	Actors with shared in-ties for B have also tie A (structural equivalence for in-ties)	
22	Closure of A for shared out-ties of B (UKT-BAB)	Actors with shared out-ties for B have also tie A (structural equivalence for out-ties)	

Notes. [a]These parameters were included to improve the fit for disliking (effect 3 to 5) and liking (effect 6 and 7). [b]These parameters were included to control for the underlying structure of the multivariate parameters for defending and liking and defending and disliking (effect 8 to 10 and 18 to 20). [c]These parameters were included to represent sex effects. The same sex effect captures tie homophily based on same sex, whereas the sex receiver (1=boy) effect measures whether boys receive more ties than girls. [d]Multivariate parameters are of main interest in this study (see Figure 5.1), and used to test our hypotheses regarding direct and indirect effects of liking and disliking on defending relations. Direct effects are measured with lower-order dyadic parameters (effect 16 and 17), and indirect effects are measured with higher-order triadic (multiple connectivity and closure) parameters (effect 21 and 22). Solid lines indicate relations of A (defending), and dotted lines indicate relations of B (liking or disliking) in the configurations of the multivariate parameters.

value of *t*-statistics below .10 for all parameters; Wang et al., 2009) was met for all classrooms, with most of them also having acceptable Goodness of Fit, referring to absolute values of *t*-statistics below 2 for (almost) all parameters (see Table S5.2 in the Supplements). In general, the models for defending and liking had a better fit than for defending and disliking.

The parameter estimates were summarized with a meta-analysis using R-package metafor (Viechtbauer, 2010) with two model specifications: one (empty) model showing the mean

estimates across all classrooms (see Table 5.8) and another model in which the additional effect of classroom bullying norms was tested (see Table 5.9).

5.10 Study 2: Results

5.10.1 Descriptive findings

Table 5.7 presents the summarized descriptive findings for the 48 classroom networks. Information per classroom is reported in Table S5.3 in the Supplements. On average, victims nominated four defenders; students nominated eleven classmates who they liked and three classmates who they disliked. Almost all students had at least one classmate they liked or disliked and nearly all victims had one defender. Disliking and defending networks were sparser than liking networks, as indicated by the density (proportion of nominations), which was higher for liking (between .25 and .64) than for disliking (at most .22) and defending (at most .25). The percentage of reciprocated nominations was also higher for liking (between 25 and 62%) than for disliking (at most 29%) and defending (at most 35%). Most liking nominations and defending were found between children with the same sex (between 56 and 86% and 59 and 100%). Indirect ties and transitivity were more common for liking than for disliking and defending.

Part two of Table 5.7 shows information about the co-occurrence of (dis)liking and defending. Victims liked the classmates they nominated as their defender (53-100%) or were liked by them (53-94%). Victims mostly did not dislike the classmates they nominated as defender (0-19%) or were not disliked by them (0-18%). Victims and their defenders infrequently shared the same likes or dislikes: the number of nominations given for defending in relation to the total number of shared received or given nominations for liking was low (3-28% and 4-33%); the same was true for disliking (4-31% and 5-29%).

5.10.2 Bivariate ERGM findings

Table 5.8 presents the meta-analysis of the estimated bivariate ERGMs, combining the parameter estimates of all classrooms in a mean with standard error. The variability of parameter estimates across classrooms is tested and indicated. Model 1 displays the results for defending and liking; Model 2 displays the results for defending and disliking.

Defending and liking

Density indicates the general occurrence of ties, comparable to the intercept or grand mean in (generalized) linear models. The negative density parameter estimates indicate an overall low occurrence of liking and defending ties (Model 1 in Table 5.8), and varies

Table 5.7 Descriptive statistics of the liking networks, defending networks, and disliking networks (48 classrooms, 1,272 students).

	Liking networks	Defending networks	Disliking networks
Density indicators			
Density[a]	.44 (.25-.64)	.11 (.04-.25)	.12 (.04-.22)
Number of ties	295 (155-473)	71 (24-127)	84 (26-230)
At least one out-tie[b]	.99 (.91-1)	.89 (.64-1)	.76 (.40-1)
At least one in-tie	1 (.96-1)	.89 (.58-1)	.76 (.36-1)
Average degree[b]	11.1 (6.4-15.8)	3.9 (1.7-8.1)	3.1 (1.0-6.4)
SD outdegree	3.6 (2.4-5.6)	5.2 (2.2-18.3)	3.2 (1.4-5.0)
SD indegree	6.3 (3.0-8.8)	3.4 (1.2-6.0)	2.8 (1.2-5.2)
Dyadic indicators			
Asymmetrical ties	235 (120-462)	102 (40-188)	122 (38-256)
Mutual ties	89 (34-146)	10 (0-28)	12 (0-51)
At least one mutual tie	.97 (.85-1)	.42 (0-.71)	.40 (0-.77)
Reciprocity[c]	.43 (.25-.62)	.16 (0-.35)	.14 (0-.29)
Same sex[d]	.69 (.56-.86)	.85 (.59-1)	.40 (.22-.85)
Triadic indicators			
Distance 2 (indirect ties)[e]	.94 (.75-1)	.50 (.12-.75)	.72 (.09-1)
Transitivity index[f]	.67 (.48-.81)	.46 (.15-.80)	.25 (.05-.60)
Total sample (students)[g]			
Sinks	.01 (0-.09)	.35 (.14-.70)	.16 (0-.46)
Sources	0 (0-0)	.06 (0-.31)	.17 (0-.45)
Isolates	0 (0-.04)	.05 (0-.30)	.08 (0-.29)
Actives	.99 (.91-1)	.54 (.15-.82)	.60 (.09-.91)
	Liking and defending networks		Disliking and defending networks
Dependence indicators			
Defending out-tie → liking/ disliking out-tie[h]	.86 (.53-1)		.02 (0-.19)
Defending out-tie → liking/ disliking in-tie[h]	.72 (.53-.94)		.05 (0-.18)
Defending out-tie → shared liking/ disliking out-tie[i]	.14 (.03-.28)		.13 (.04-.31)
Defending out-tie → shared liking/ disliking in-tie[i]	.14 (.04-.33)		.14 (.05-.29)

Notes. Table shows averages per classroom. Minimum and maximum are shown in parentheses. [a]Density is the number of observed ties divided by the total number of possible ties. [b]For defending networks, this was counted among those who indicated being victimized by classmates (based on the general Olweus (1996) self-reported items measuring peer victimization). [c]Reciprocity was calculated as $2M/(2M + A)$, where M = mutual ties and A = asymmetric ties. [d]Calculated as the proportion of defending, liking, or disliking ties that are also same sex. [e]Distance 2 is the proportion of respondents with ties at two degrees of separation (with at least one connecting intermediary). [f]Transitivity was calculated as the number of transitive triplets divided by the number of 2-paths (or 2-stars). [g]Sinks are actors with zero out-ties and at least one in-tie, sources are actors with at least one out-tie and zero in-ties, isolates are actors with zero in-ties and zero out-ties, and actives are actors with at least one out-tie and at least one in-tie. [h]Proportion of out-ties for defending that are also out-/in-ties for (dis)liking. [i]Proportion of shared outgoing W-ties (*i* and *j* like/dislike the same person *h*) and incoming W-ties (*i* and *j* are liked/disliked by the same person *h*) for which there are also outgoing X-ties (*i* nominates *j* as his/her defender).

significantly across classrooms. *Reciprocity* indicates the general occurrence of reciprocation of ties. The positive reciprocity parameter estimate reveals that students tended to like the classmates who liked them as well and to defend the classmates who defended them. The large positive same-sex parameter estimates and negligible receiver effects indicate that liking and defending relations tended to occur mainly among boys and among girls, approximately equally often, with significant variation across classrooms.

The positive Multiplex ArcAB parameter (b = 2.32, p < .001) and positive Multiplex ReciprocityAB parameter (b = 0.90, p < .001) indicate that victims are more likely to be defended by the classmates they liked and who liked them, consistent with the hypotheses about the *direct* effect of liking and being liked on defending (hypotheses H1a1 and H1a2). With respect to the hypotheses that victims are more likely to be defended by the classmates to whom they are *indirectly* positively connected, mixed results were obtained: the positive parameter estimate Closure of A for shared in-ties of B (b = 0.36, p < .001) indicate that victims tend to be defended by the classmates whom are liked by the same person as they are liked by themselves (H1b1), but not by those who like the same children as they do (H1b2), in view of the negative Closure of A for shared out-ties of B parameter (b = -0.14, p = .011).

Defending and disliking

The analysis of defending and disliking (Model 2 in Table 5.8) shows many comparable results to those in Model 1. The occurrence of disliking ties was low and disliking ties were often reciprocated, occurring mostly in cross-sex dyads, although boys tended to be more disliked than girls with significant variation across classrooms. Different than in the liking networks, students were disliking others without being disliked themselves (as indicated by the positive estimate of sources parameter) or were disliked without disliking others themselves (positive estimate of sinks) or were uninvolved in disliking ties (positive effect for isolates).

In line with the direct hypotheses (H2a1 and H2a2), victims were not likely to be defended by the classmates they disliked (negative Multiplex ArcAB; b = -0.68, p = .06) or who disliked them (negative Multiplex ReciprocityAB; b = -0.32, p < .01). Support was also found for the indirect hypotheses (H2b1 and H2b2): A victim was not likely to be defended by a classmate if both are disliked by the same classmate(s) (H2b1, negative Closure of A for shared in-ties of B; b = -0.30, p < .001), or if both disliked the same classmate(s) (H2b2, negative Closure of A for shared in-ties of B; b = -0.16, p = .04).

Table 5.8 Bivariate ERGM meta-analysis results for univariate and multivariate parameters for liking, disliking, and defending networks.

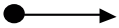
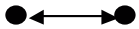
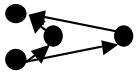
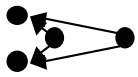
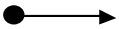
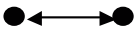
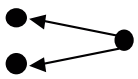
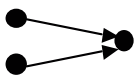
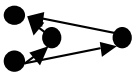
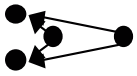
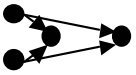
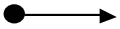
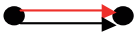
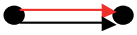
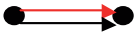
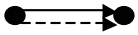
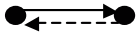
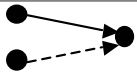
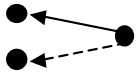
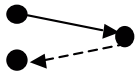
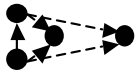
			Model 1: Defending and liking			Model 2: Defending and disliking[c]		
Parameter (statistic)		Illustration	n	Est.	SE	n	Est.	SE
Univariate parameters: Defending (A)								
Dyadic parameters								
1	Density (Arc)		48	-4.60**	.31†	48	-4.80**	.22†
2	Reciprocity		46	.60**	.12	46	1.24**	.12
Multiple connectivity and closure parameters								
8	Multiple two-paths (A2P-T)		42	-.10*	.05	47	-.12**	.04
9	Shared in-ties (A2P-D)		42	-.05	.06	47	.27**	.04
Sex covariate parameters								
11	Sex (1=boy) receiver		48	-.16	.14†	48	-.06	.13†
Network covariate parameters								
12	Same sex[a]		45	1.26**	.16†	45	1.87**	.17†
13	Bully		25	-.19	.19	25	-.17	.20
14	Like					48	2.03**	.13†
15	Dislike		23	-.87**	.20			
Univariate parameters: Liking/Disliking (B)								
Dyadic parameters								
1	Density (Arc)		48	-3.32**	.20†	48	-2.01**	.12
2	Reciprocity		48	.58**	.08	42	.96**	.11
Degree parameters								
3	Sinks					36	2.05**	.24†
4	Sources					36	1.29**	.16
5	Isolates					22	2.85**	.26
6	In-2-stars		26	.03	.04			
7	Out-2-stars		37	.21**	.03			

Table 5.8 Continued.

Parameter (statistic)	Illustration	Model 1: Defending and liking n	Est.	SE	Model 2: Defending and disliking[c] n	Est.	SE
Multiple connectivity and closure parameters							
8 Multiple two-paths (A2P-T)		48	-.04	.03	43	-.03	.04
9 Shared in-ties (A2P-D)		45	.18**	.05	47	.12**	.04
10 Shared out-ties (A2P-U)		48	-.04	.05	48	.17**	.04
Sex covariate parameters							
11 Sex (1=boy) receiver		48	.11	.08	48	.17*	.07
Network covariate parameters							
12 Same sex		48	1.22**	.08	48	.01	.08
13 Bully		45	-.58**	.15†	46	1.77**	.17†
14 Like					30	-3.19**	.16
15 Dislike		32	-3.39**	.20†			
Multivariate parameters: Interplay[b]							
Dyadic parameters[c]							
16 Multiplex ArcAB		48	2.32**	.10	15	-.68+	.36
17 Multiplex ReciprocityAB		48	.90**	.09	37	-.32**	.12
Mixed dyadic parameters							
18 In2StarAB		48	.11**	.03	48	-.08+	.04
19 Out2StarAB		48	-.06*	.02	47	.06+	.03
20 Mixed2StarAB		47	-.09**	.03	47	.02	.04
Multiple connectivity and closure parameters							
21 Closure of A for shared in-ties of B (DKT-BAB)		48	.36**	.05	47	-.30**	.08
22 Closure of A for shared out-ties of B (UKT-BAB)		48	-.14*	.05	48	-.16*	.08

Notes. Significance tests performed by dividing the estimates with its standard error resulting in *t*-Values which under the null hypothesis are approximately normally distributed. *$p \leq .05$, **$p \leq .01$ (two-tailed test). [a]In three classrooms, all defending ties were same-sex (see Table S5.3 in the Supplements), resulting in complete overlap with defending density and non-convergence. Hence, in these cases the same sex effect was left out. [b]Multivariate parameters are of main interest in this study, and used to test our hypotheses about direct and indirect effects of liking and disliking on defending relations. Direct effects are measured with lower-order dyadic parameters, and indirect effects are measured with higher-order triadic (multiple connectivity and closure) parameters. Solid lines indicate relations of A (defending), and dotted lines indicate relations of B (liking or disliking) in the configurations of the multivariate parameters. [c]A substantial number of dyadic multiplex parameters was left out because the accompanying statistics (network configurations) were absent. As part of the sensitivity analysis, the models excluding these parameters were re-estimated with a fixed value (-1) for the dyadic multiplex parameters. No substantial differences were found between the "fixed model" and the models that did not include them (results available upon request). [†]Significant differences between classrooms.

Table 5.9 Bivariate ERGM meta-analysis results for univariate and multivariate parameters for defending and dis/liking networks – effects of classroom bullying norms.

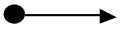
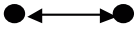
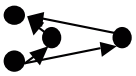
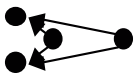
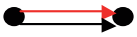
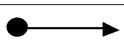
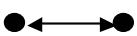
			Model 1 Liking Bullying norms[d]			Model 2 Disliking Bullying norms[d]		
Parameter (statistic)		Illustration	n	Est.	SE	n	Est.	SE
Univariate parameters: defending (A)								
Dyadic parameters								
1	Density (Arc)		48	-.45	.48	48	-.34	.33
2	Reciprocity		46	-.18	.19	46	-.17	.18
Multiple connectivity and closure parameters								
8	Multiple two-paths (A2P-T)		42	.03	.07	47	.03	.06
9	Shared in-ties (A2P-D)		42	.02	.10	47	.08	.06
Sex covariate parameters								
11	Sex (1=boy) receiver		48	.41+	.21	48	.45*	.19
Network covariate parameters								
12	Same sex[a]		45	-.01	.25	45	.02	.26
13	Bully		25	-.70*	.31	25	-.71*	.31
14	Like					48	-.24	.19
15	Dislike		23	-.54+	.32			
Univariate parameters: dis/liking (B)								
Dyadic parameters								
1	Density (Arc)		48	.14	.30	48	-.24	.18
2	Reciprocity		48	.19	.12	42	.07	.19
Degree parameters								
3	Sinks					36	.12	.36
4	Sources					36	.05	.25

Table 5.9 Continued.

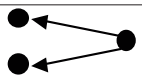
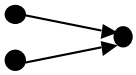
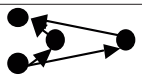
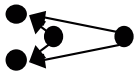
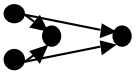
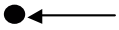
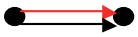
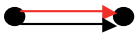
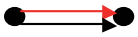
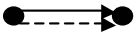
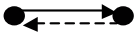
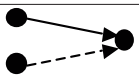
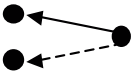
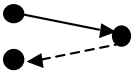
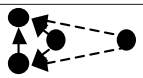
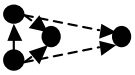
Parameter (statistic)	Illustration	Model 1 Liking Bullying norms[d] n	Est.	SE	Model 2 Disliking Bullying norms[d] n	Est.	SE
5 Isolates					22	-.08	.41
Degree parameters							
6 In-2-stars		26	-.02	.07			
7 Out-2-stars		37	-.01	.04			
Multiple connectivity and closure parameters							
8 Multiple two-paths (A2P-T)		48	.03	.05	43	-.001	.06
9 Shared in-ties (A2P-D)		45	-.05	.09	47	.01	.06
10 Shared out-ties (A2P-U)		48	-.08	.07	48	-.02	.06
Sex covariate parameters							
11 Sex (1=boy) receiver		48	-.24*	.12	48	.26*	.11
Network covariate parameters							
12 Same sex		48	-.09	.12	48	.11	.13
13 Bully		45	.26	.24	46	.31	.26
14 Like					30	-.12	.25
15 Dislike		32	-.04	.30			
Multivariate parameters: interplay[b]							
Dyadic parameters							
16 Multiplex ArcAB		48	-.03	.15	15	-.72	.54
17 Multiplex ReciprocityAB		48	-.001	.14	37	-.32	.19
Mixed dyadic parameters							
18 In2StarAB		48	.01	.05	48	-.02	.07
19 Out2StarAB		48	-.01	.03	47	-.001	.05
20 Mixed2StarAB		47	-.01	.04	47	.05	.06

Table 5.9 Continued.

			Model 1 Liking Bullying norms[d]			Model 2 Disliking Bullying norms[d]		
Parameter (statistic)		Illustration	n	Est.	SE	n	Est.	SE
Multiple connectivity and closure parameters[c]								
21	Closure of A for shared in-ties of B (DKT-BAB)		48	.02	.07	47	-.10	.13
22	Closure of A for shared out-ties of B (UKT-BAB)		48	.03	.08	48	.07	.12

Notes. [a b c] See Notes in Table 5.8. [d]Intercept was left out of in this table (the "baseline effect" when bullying norms are "zero") because it was comparable to the estimates reported in Table 5.8. To facilitate the interpretation of the results, scores for bullying norms were grand mean centered. Using defending density as an example, a 1-unit increase in bullying norms (referring to +1 above the mean score) results in a -0.45 (-0.34) decrease in density in terms of the average effect estimate. [†]Significant differences between classrooms.

Bullying norms: defending

The meta-analyses of the density parameter estimates does not indicate that defending was lower in a classroom where bullying was high (H3a, see meta-analysis results in Table 5.9).

Bullying norms: defending and liking

There was also no evidence of reduced effects of direct and indirect liking. See Table 5.9 and Figure 5.3 and Figure 5.4.

Bullying norms: defending and disliking

The direct effect of co-occurrence of defending and disliking is lower (but not significantly) in classrooms with high bullying norms (see Table 5.9 and Figure 5.5), indicating that victims were less likely to be defended by classmates they disliked (H3d1, stronger negative Multiplex ArcAB effect), with some, although weaker evidence for victims to be less defended by classmates who disliked them (see Figure 5.5). The results also point to more defending by boys in classrooms with high bullying norms, and boys being less liked (and more disliked) in those classrooms, and for victims to nominate their bullies less often as their defenders.

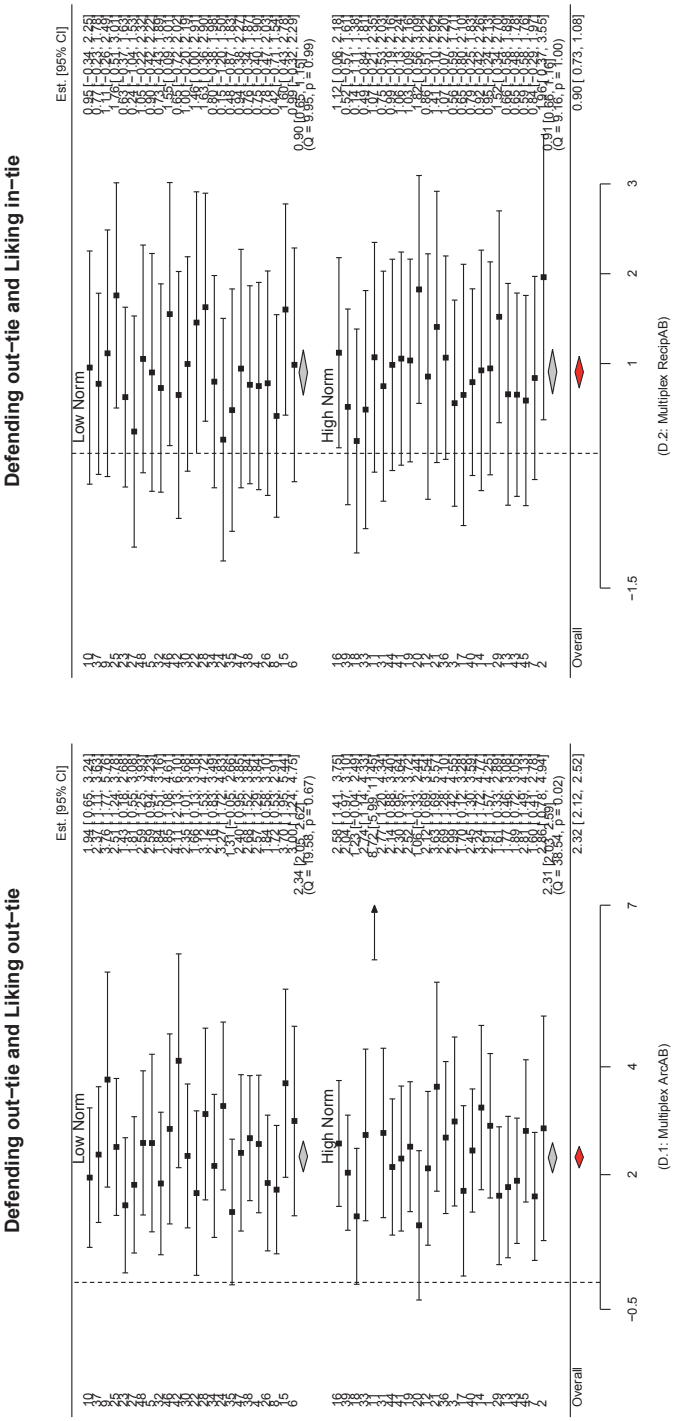


Figure 5.3 Forest plots of estimates of direct effects of liking on defending.

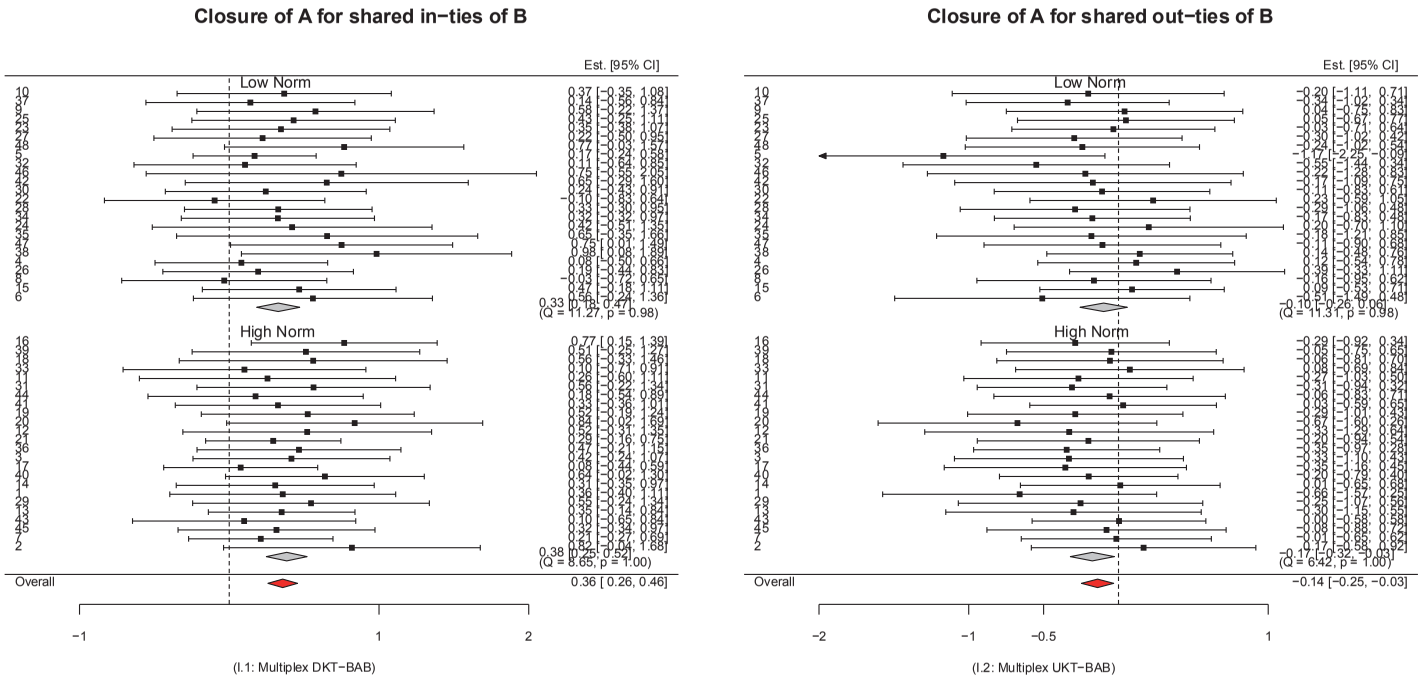


Figure 5.4 Forest plots of estimates of *indirect* effects of liking on defending.

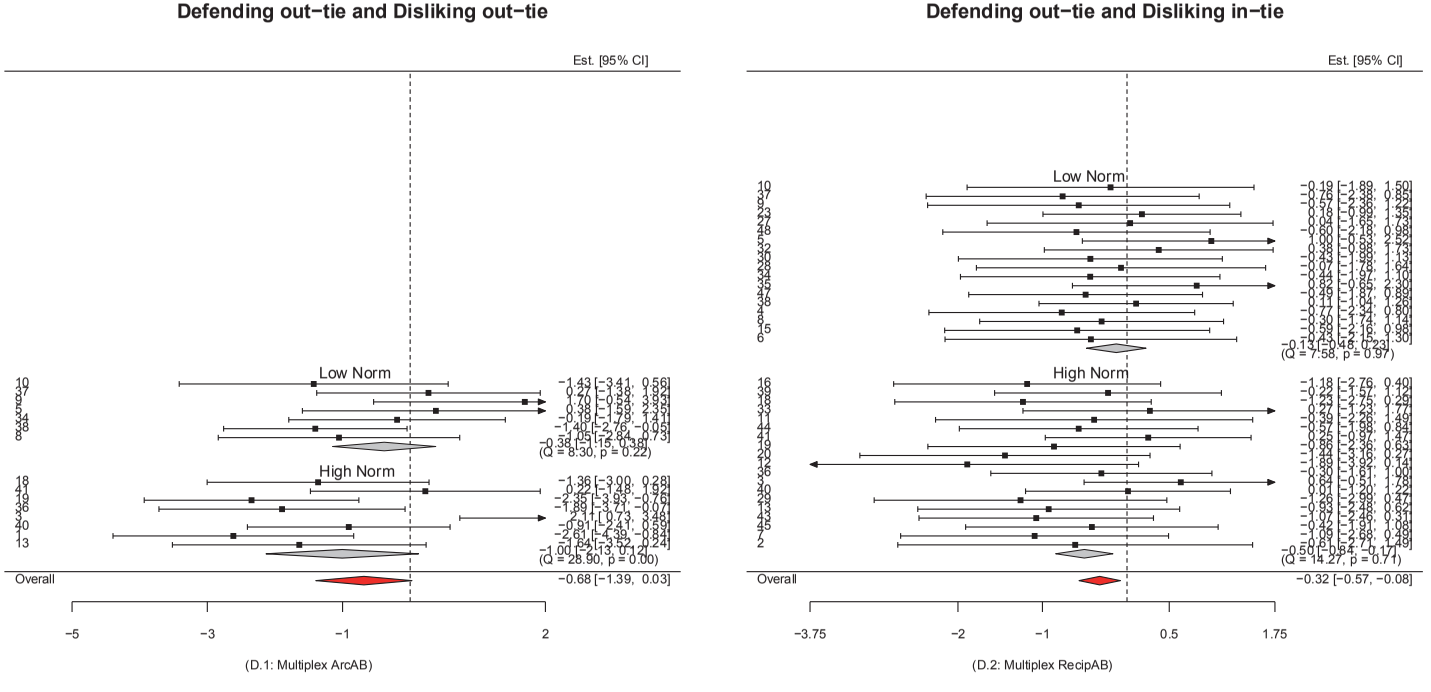


Figure 5.5 Forest plots of estimates of direct effects of disliking on defending.

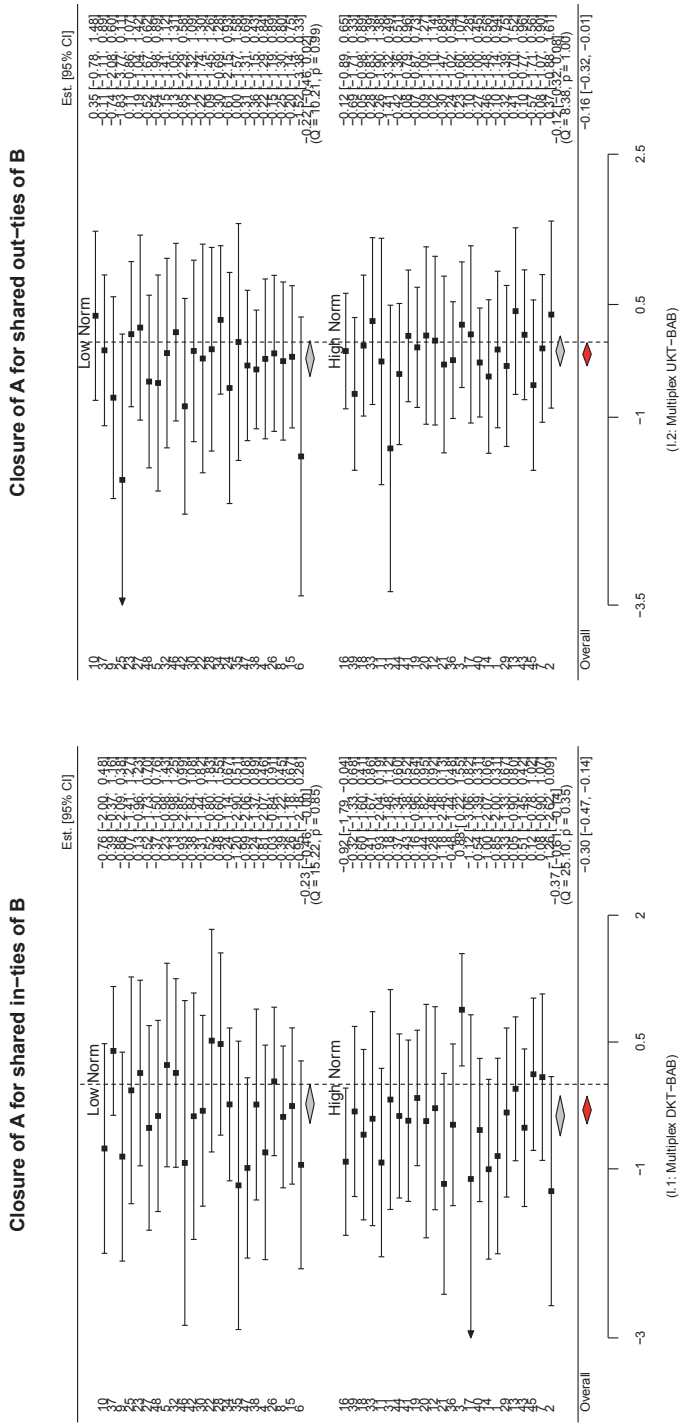


Figure 5.6 Forest plots of estimates of *indirect* effects of disliking on defending.

5.11 Discussion

Defenders have a significant impact on the well-being of the victims: they can mitigate the negative consequences of victimization, for example, by making victims less anxious, less depressed, and increase their self-esteem (Sainio et al., 2011). It is thus not reassuring that only one fifth of the students are defenders of victims and that not all victims are defended by peers (Salmivalli, 2010). In this study, we investigated the extent to which defending depends on the (dis)liking relationships between defenders and victims, and their relationships with other classmates as well as the influence of the amount of bullying in the classroom (defined as the bullying norm) herein. We employed two possible analytical approaches to answer our questions: multilevel analysis to analyze individual defending rates, and social network analysis to analyze defending networks, with the further aim to investigate the differences in these two approaches with respect to their substantive conclusions.

5.11.1 The role of liking and disliking

The findings from both approaches are in line with the hypothesis that students who are more liked and less disliked by the victims are more often nominated as defender by the victims. The results mirror previous research on the relation between defending and social standing in the group (Caravita et al., 2009; Kollerová et al., 2018; Pöyhönen et al., 2012; Pronk et al., 2017; Salmivalli et al., 1996; van der Ploeg et al., 2017), and previous work on defending and friendships and dislike relations (Oldenburg et al., 2018).

The findings from both approaches also show that the direct effect of liking is much stronger than the direct effect of disliking. Thus, the positive judgments or social evaluations of the defenders by victims outweigh the negative judgments. This may be understood by viewing defending as prosocial or helping behavior (Sainio et al., 2011; Meter & Card, 2015; Pronk et al., 2019), where the defenders may be rewarded by a positive social evaluation by the victim and, if needed, by being defended themselves at other times (Huitsing & Veenstra, 2012; Meter & Card, 2015; Salmivalli et al., 1997; Thornberg et al., 2012).

The network approach sheds more light on the nature of defending ties in terms of reciprocity between defending and (dis)liking. It also shows the importance of (local) subgroup processes of defending in liking and disliking networks by revealing the importance of both defenders' and victims' judgments as well as the judgments of other classmates to whom victims and defenders are tied.

5.11.2 The role of bullying norms

In both approaches, no effect of bullying norms was found. We note, however, that our operationalization of bullying norms is subject to discussion. It is hard to compare these findings to what previous studies on class norms have found as researchers typically relied on self-reports instead of peer nominations (Henry et al., 2002; Sentse et al., 2007; Wright, Giammarino, & Parad, 1986). It would make sense to include social standing when refining the operationalization of bullying norms. This norm salience (or social prestige norm) approach refers to the perceived values or social rewards attached to specific behaviors (Galvan, Spatzier & Juvonen, 2011). It may reveal whether children defend victims when social rewards (or social risks) attached to defending are higher (Peets et al., 2015). Like bullies, defenders also strive toward social status in the peer group (Pronk et al., 2019), albeit differently: bullies through antisocial means and defenders through prosocial means.

Students may also be influenced by injunctive norms (Henry et al., 2000), which reflect classmates' beliefs about the acceptability of behavior (Cialdini et al., 1990), referring to what people are expected to do in a certain situation (Deutsch & Gerard, 1955). Students may be more inclined to defend victims when their peers expect them to do so. Normative beliefs of students may also be driven by sex, which may be particularly relevant for defending, which, to a large extent, is a gendered process: that is, girls defend mainly other girls and boys defend mainly other boys (Sainio et al., 2011; Thornberg & Wänström, 2018). For both boys and girls, the judgments of other boys or other girls may thus be more important than the judgments of all classmates (referring to gender classroom norms; Busching & Krahé, 2015).

Apart from these operationalization issues, the cross-sectional approach of the current study is not able to account for the possible change in bullying norms and defending and (dis)liking ties. It is known that bullying roles are not unique and stable (Salmivalli, 2010): bullies may change victims to maintain a high status in the group (van der Ploeg et al., 2019); similarly, defending (relations) is also subject to change (Huitsing et al., 2014; Sijtsema et al., 2014).

5.11.3 Conclusion

The main findings from both approaches are similar and indicate that defending behavior depends most importantly on sympathy between defender and victim. In assessing whether an individual approach or a social network approach is superior in examining defending and its relation with (dis)liking and bullying norms, we consider the methodological and statistical pros and cons. Although the social network approach is more difficult and time-

consuming to execute, it is statistically the preferred option because it does not violate the assumption of independence of observations within classrooms. The individual approach suffers more from multicollinearity because of the coarser measures. The outcome of the individual approach therefore enables conclusions to general hypotheses, whereas the social network approach allows researchers to test more subtle or intricate hypotheses (with the challenge to formulate such hypotheses with enough precision). Although a broader conceptualization of bullying norms may be warranted, the findings from the network approach suggest that bullying norms play a negligible role in the relation between defending and (dis)liking: irrespective of the classroom degree of bullying, defending is first and foremost driven by the direct friendly relationship between victim and defender, and to a lesser extent by the shared relationships with other classmates.

Chapter 6

Conclusion and Discussion

This final chapter summarizes the research findings related to the school and classroom factors on bullying, victimization, and defending investigated in this study, discusses their implications, and indicates considerations for future research.

6.1 Summary and discussion of the findings

Bullying is the most common form of school violence among classmates and is generally seen as a group process (Menesini & Salmivalli, 2017). Much emphasis has been put on individual factors to explain bullying, such as temperament, personality, cognition, and emotion (Rivara & Le Menestrel, 2016); however, children are encapsulated in contexts, such as classrooms and schools. Moreover, classrooms vary greatly in rates of bullying behavior, peer victimization, and defending behavior (Salmivalli, 2010). This thesis aimed to understand which classroom factors might increase or decrease the risk for bullying among classmates (Brendgen & Troop-Gordon, 2015; Juvonen & Graham, 2014). So far, few studies provide insight on this matter for bullying behavior, peer victimization, and defending among students in elementary education.

To enhance our understanding of the extent to which bullying behavior and peer victimization depend on classroom factors, I adopted a relational framework (Rodkin et al., 2015) throughout this thesis. In this framework, bullying and peer victimization are considered as relational processes, by considering the power (status) asymmetry between bullies and their victims (Volk et al., 2014). For understanding the occurrence and development of positive peer relations, such as helping relationships between students, I adopted an evolutionary framework that involves communion (Ellis et al., 2012; Volk et al., 2012), referring to relational needs, affiliation, and closeness/intimacy (Ojanen, Sijtsema, & Rambaran, 2013). In the classroom context, this means that youth are (being) motivated to develop healthy peer relationships such as friendships and support relations. The two theoretical frameworks utilized in this thesis can be implied in a broader sense to help understand the occurrence and development of positive and negative peer relationships in school and classroom settings.

To answer the overarching question whether and to what extent bullying, victimization, and defending depend on the classroom context factors, I investigated classroom context

factors from two different angles: classroom composition on the one hand (structure and stability), and social relations and social norms (friendships and classroom climate) on the other hand. In this final chapter, I will summarize and discuss the findings. Figure 6.1 presents an overview of the research questions and empirical findings.

In four empirical studies, this thesis examined classroom context factors using social network analysis, focusing on structural factors (study 1 and study 2) and social factors (study 3 and study 4). Chapter 2 (study 1) examined degrees and direction of victim-bully ties in single-grade and multigrade classrooms to examine power differences based on age and grade. Chapter 3 (study 2) investigated the effect of stability in classroom composition on changes in victim-bully ties (that is, in schools with single-grades and multigrades). Chapter 4 (study 3) examined the dynamic interplay between victim-bully ties and friendship ties. Finally, Chapter 5 (study 4) examined social norms (through degree of bullying) and (dis)like ties in defending ties using an individual multilevel and social network approach.

6.1.1 Better off in single-grade than in multigrade classrooms?

In the first study, Chapter 2, I investigated whether and to what extent victim-bully relationships depend on (relative) age differences in a sample of single-grade classrooms where age differences between students are small and multigrade classrooms where age differences between students are large in order to study the effect of power imbalance on victimization in different classroom contexts. I found no evidence of differences in victimization prevalence in both types of classrooms nor evidence from the social network analyses (ERGMs) that victimization is associated with (relative) age and grade differences in any of the examined classroom contexts. Findings also revealed no clear sex differences in bullying involvement in single-grade and (administrative and pedagogical) multigrade classrooms.

Previous research pointed in the direction that children in administrative multigrade classrooms are not better or worse off in terms of socio-cognitive outcomes (e.g., academic achievement and social adjustment). In Chapter 2, I extend this research by showing that there is also no indication that multigrade classrooms increase the risk of victimization by classmates. This conclusion contradicts research showing that younger children are vulnerable in terms of victimization compared to their older classmates (Chaux & Castellanos, 2015).

In Chapter 2, I found that victimization relations in administrative multigrade classrooms occurred mostly between students who are in the same grade in their classroom, thus between children whose age differences are relatively small. This finding is in line with

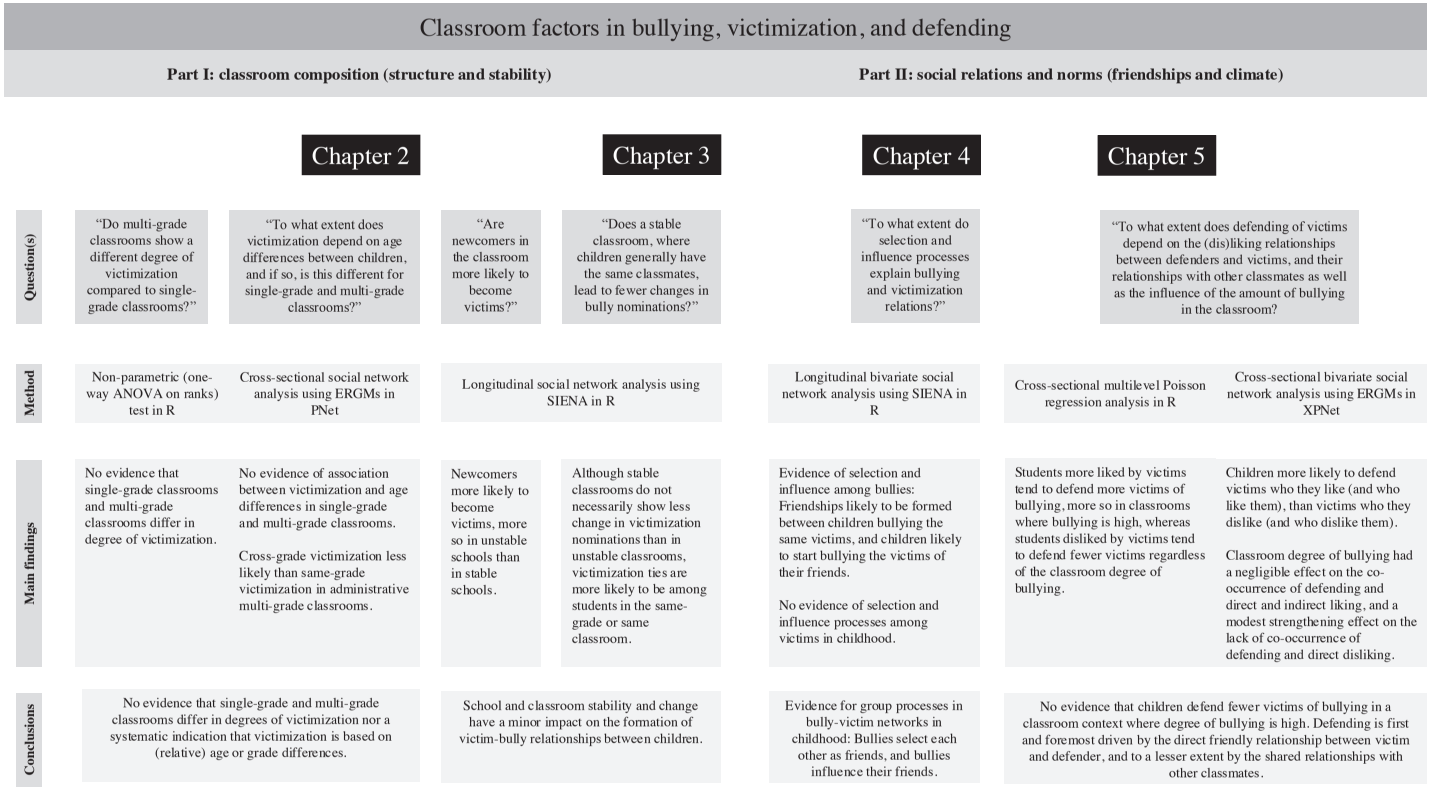


Figure 6.1 Overview of the study questions and main findings and conclusions of the empirical chapters in this thesis.

Chapter 6

previous research which shows that, besides a few socially isolated children, the highest rates of victimization are observed among students who have similar status positions, not necessarily between students with the highest status and the lowest status in the group (Farris & Felmlee, 2011; 2014). This implies that age and grade differences in schools and classrooms contribute relatively little to a power imbalance between students.

Interestingly, Chapter 2 found that the degree of victimization was similar in both single-grade classrooms and multigrade classrooms that are formed for administrative reasons, but lower in multigrade classrooms that are formed for pedagogical reasons. Although these findings were based on a few classrooms, they are in line with the pedagogical philosophy of schools to encourage prosocial relations among children by encouraging the provision of help across grades within the same classroom (Lillard & Else-Quest, 2006; Gray, 2011).

It should be pointed out that schools that have different grades within the same classroom as a consequence of grade/classroom mixing tend to be unstable in terms of student classroom composition over school years. Hence, an obvious next question is how this grade/classroom mixing affects children in terms of bullying and peer victimization, which is the focus of the research carried out in Chapter 3.

6.1.2 Classroom mixing and its consequences?

In the second study, Chapter 3, I investigated to what extent (stable) single-grade schools (with few classroom composition changes) or (unstable) multigrade schools (with many changes) lead to fewer changes in victim-bully relationships. Results of the longitudinal social network analyses (RSiena) showed that although stable schools do not necessarily show less change in bully nominations than in unstable schools, victim-bully relationships were more likely to form among students in the same grade and same classroom. Newcomers in the classroom were more likely to become victims, more so in unstable schools than in stable schools.

The findings of Chapter 3 suggest that school and classroom stability and change have a small impact on the formation of victim-bully relationships between children: the analyses provided no evidence that students who shared the same class before (referring to the number of shared classrooms) were more likely to be victimized in the stable schools with occasional classroom composition changes than in unstable schools with systematic changes. To some extent these findings are reassuring for schools that have to deal with changing conditions in their student population. Particularly in small cities or villages that undergo a decline in enrollment of students, an increase of uneven classroom sizes, and schools often consist of only a few school teachers (Veenman, 1995), schools are often forced to combine classrooms or grades.

However, although the findings from Chapter 3 suggest that classroom mixing has a relatively modest impact on the development of victimization relations, it may have consequences for the development of other interpersonal relations between students. Children may experience difficulties with maintaining friendships with their classmates when some of them move to a different classroom in the following school year. Previous research found that stability in the classroom composition positively affects the stability of friendship cliques (Neckerman, 1996). These findings suggest that classroom mixing may be detrimental for victims who experience difficulties with finding new friends and peers who are willing to defend them against their bullies. At the same time, classroom mixing also offers an opportunity for victims to make new friends. Previous studies have shown that having friends or defenders helps to protect victims against a vicious cycle of victimization and its negative experiences (Hodges et al., 1999; Sainio et al., 2011). A safe conclusion is that positive and negative relations do not operate in isolation, but are an integral part of the social context in which these relations unfold. To this end, the research carried out in the next study (Chapter 4) was designed to help understand how bullying relations and peer victimization in classrooms develop in the context of friendships with classmates.

6.1.3 Bullying as a group process in elementary education?

Although research suggests that bullying does not occur in isolation from other classmates, but takes place in the presence of several other members of the group (Salmivalli, 2010), most previous studies on bullying concentrated only on the victim-bully relationship (which was also the focus of the studies in Chapters 2 and 3). The participant roles approach suggest that classmates have (different) roles in bullying (Salmivalli et al., 1996; Salmivalli, 2010). Some children initiate the bullying, and others actively or passively join in. Bullies may influence their friends so that they too will start to bully the same victim. To test these ideas, in Chapter 4, I examined to what extent friendship selection and influence/ contagion processes affect the formation and development of victim-bully relationships using longitudinal social network analyses (RSiena). The findings provide evidence for friendship selection and influence processes in bully-victim networks in childhood: Friendships developed between children who bullied the same classmate (selection), and victims were bullied by their bully's friends (influence). By examining bullying relations together with friendships, two important features of bullying among school children are highlighted, namely its collective character (referring to the behavior of a group of individuals), and that it is based on social relationships in the group (Salmivalli et al., 1996; Lagerspetz et al., 1982). The findings suggest that bullies through friendships with classmates experience direct support for their bullying behavior. The findings indicate that in order to better understand the social nature of victim-bully relationships, they should be studied in combination with positive social relationships.

The degree of bullying is an indication of social norms in the classroom (Salmivalli, 2010; Sentse et al., 2007), as it can be viewed as what most others do in a given situation or social context (Deutsch & Gerard, 1955; Cialdini et al., 1990). Such norms might help to understand why classmates are less likely to intervene in bullying by defending fewer victims (Salmivalli, 2010; Salmivalli, Voeten, & Poskiparta, 2011), which is the focus of the final study in Chapter 5.

6.1.4 Bullying in a classroom context and defending victims?

In the fourth and final study, Chapter 5, I examined the extent to which victim-defending relationships depend on the (dis)liking relationships between defenders and victims, and their relationships with other classmates. I also examined the extent to which the amount of bullying in the classroom (defined as the bullying norm) affect these relations. The relations between defending, (dis)liking, and the bullying norm were examined using two analytical approaches: a multilevel individual (Poisson regression analysis) and a social network approach (ERGMs).

I examined defending relations in late childhood, among fifth-graders, because by then peer hierarchies related to bullying are established (Farmer et al., 2011b). Moreover, at this stage of childhood, students have a higher degree of self-efficacy making them more able to engage in defending than younger children (Meter & Card, 2015). Further, as children grow older they learn about diverse social strategies to solve situations without using aggression. This puts them in a stronger position to help others (victims) in need.

Multilevel Poisson regression analysis showed a positive relation between defending and liking nominations by victims, which was stronger in a classroom with a higher degree of bullying, with no additional effect of disliking. The social network analysis indicated that defending is first and foremost driven by the direct friendly relationship between victim and defender, and to a lesser extent by the shared relationships with other classmates, which is in line with preconceptions concerning defending (Meter & Card, 2015; Thornberg et al., 2012). It should be noted that the direct reasons for why children refrain from defending were unexamined.

The findings from both approaches also show that the direct effect of liking is much stronger than the direct effect of disliking. Apart from a strengthening effect of bullying norms on the relation between liking and defending in the individual approach, no other effect of bullying norms was found. It should be noted, however, that although descriptive norms (referring to the average bullying behavior) are widely used in bullying research, there are other ways to examine classroom norms. Norm salience – referring to the association between social status and behavior or attitudes, might be relevant (Dijkstra & Gest, 2015;

Laninga-Wijnen et al., 2017; Rambaran, Dijkstra, & Stark, 2013). Of further relevance are injunctive norms – referring to expectations about social rewards attached to behavior or attitudes (Henry et al., 2000), which might operate differently for boys and girls (Busching & Krahé, 2015). The investigation of classroom norms would benefit from further refinements in that field. Future researchers are encouraged to take on a wider perspective of classroom norms.

6.2 Insights and directions for future research

Doing social network research has gained popularity in (social) science in recent years (Robins, 2015), because of the fact that 1) more researchers acknowledge that behaviors they previously considered as individual attributes of students are actually relational; and, 2) advancements in social network methods have made it possible to investigate the dependencies in relational patterns (network structure).

Collectively, the four empirical studies in this thesis have revealed insights regarding the importance of (1) the network structure, sex, and grade (age), (2) interdependence of networks, (3) classroom composition changes, (4) and the analytic approach in understanding bully-victim and victim-defender relationships across different classroom contexts. I will discuss some directions for future research, focusing on other school and classroom factors, positive peer relations, early childhood and (early) adolescent networks, and individual factors.

6.2.1 Network structure, sex, and grade (age)

The first two studies revealed that networks of peer victimization are similar in single-grade and multigrade classrooms (Chapter 2) and schools (Chapter 3). The peer victimization networks in these two different school and classroom types have the same network structure. These findings suggest that although single-grade and multigrade schools and classrooms differ in how they were formed, peer victimization in these different contexts showed the same network structure. The structure of the sparse victimization networks in both classroom and school types can be characterized by a few simple network structures. Complex structural network patterns involving indirect connections are hardly present in these sparse (low density) networks. This is common for bully-victim networks (Huitsing et al., 2012; Huitsing & Veenstra, 2012), reflecting the power imbalance between the bully and victim. This information might be beneficial to researchers who consider removing multigrade classrooms from their sample of networks for a "meaningful comparison" between classrooms.

Next to the importance of the network structure, students' sex and their grade (age) proved to be important in understanding networks of bully-victimization and of defending. Although differences between the investigated school and classroom contexts were relatively minor, as shown in study one (Chapter 2), study two (Chapter 3), and study three (Chapter 4), boys were more involved in bullying than girls and targeted both girls and other boys. This finding underscores that bullying situations are being dominated mostly by boys. These gendered processes in bullying may have spillover effects on positive peer relationships of children. Concerning friendship and defending processes, friendship and defending occurred mostly between children of the same sex, as shown in study three (Chapter 4) and four (Chapter 5). Researchers should be aware of same-sex and cross-sex patterns in bully-victim networks. Also students' grade (age) in a school or classroom context is highly relevant in understanding bully-victim networks. In fact, same-grade victimization appeared to be the strongest predictor of victim-bully ties (next to network structure), as shown in study one (Chapter 2) and study two (Chapter 3). Particularly in stable (single-grade) schools same-grade victimization is very high, which might be due to maintaining separate classrooms (grades) across the school years. In multigrade classrooms and schools, victimization occurs mostly between same-grade students.

6.2.2 Interdependence of networks

The final two studies (in Chapter 4 and Chapter 5) revealed that bully-victim networks and victim-defending networks cannot be seen separately (as univariate networks) but are better understood through analyzing them together with other network types. By applying a multivariate network approach, researchers are able to better understand the occurrence and development of more complex network structures that result from the interdependence of networks. In the third study (Chapter 4), it was shown, through triangulation of positive (friendship) and negative (bullying) networks, that victim-bully relationships were related to friendships groups; in the fourth study (Chapter 5) it was shown that victim-defending relationships were related to (dis)liking relationships at the dyadic and triadic level. This information might be beneficial to researchers who study relational behavior.

6.2.3 Classroom composition changes

For social network scientists low stability in school and classroom composition often forms a major concern, as this complicates the estimation procedure, particularly in the case of sparse networks such as bully-victim networks. Methodologically, the second study (Chapter 3) shows how to deal with schools with many changes in classroom composition. In this study, I demonstrated how bully-victim networks with low composition stability at the classroom level can be examined in a meaningful way at the school level. There, I incorporated effects in the network model that captured stability and change in classroom

composition, enabling examination of their effects on victim-bully relationships. This information might be beneficial to researchers who deal with many composition changes at the classroom level.

6.2.4 An individual or social network approach

Chapter 5 provides a direct comparison of two different approaches for examining relational behavior. Most (bullying) researchers tend to aggregate peer nomination data into individual-level measures instead of treating them as they were measured namely as network relations. The fourth and final study (in Chapter 5) aimed to find out the differences between these two approaches. It is clear that the findings from both approaches are similar and indicate that defending behavior depends most importantly on sympathy between defender and victim. Nonetheless, the social network approach is superior in examining defending and its relation with (dis)liking and bullying norms. It is statistically the preferred option because it does not violate the assumption of independence of observations within classrooms. Moreover, it allows researchers to test more subtle or intricate hypotheses (with the challenge to formulate such hypotheses with sufficient precision).

6.2.5 Some directions for future research

Other school and classroom factors

It is important to realize that the school and classroom factors investigated in this thesis are not exhaustive. There are many other school and classroom factors that were not investigated (for an overview, see: Juvonen, 2018; Juvonen & Schacter, 2018), such as homogeneity of the student body, an unequal representation and status across groups, low tolerance of norm violations, and teaching methods promoting independence or negative interdependence (referring to competition) among students. These factors have been linked to an increased risk of negative attitudes, interactions, and peer relationships, and might thus also be relevant for the occurrence and development of bullying, victimization, and defending relations (Juvonen, 2018; Juvonen & Schacter, 2018). The many of school and classroom contextual factors pose a major challenge for researchers to find out which of them are important and under which circumstances they matter the most. I will discuss inclusive classroom norms as a promising avenue for future research.

Schools with more ethnic diversity who deal with bullying situations that are related to ethnic, cultural or racial background of the student may foster cross-ethnic friendships between students through inclusive norms for cross-ethnic relations (Tropp, O'Brien, & Migacheva, 2014; Monks, Ortega-Ruiz, & Rodríguez-Hidalgo, 2008). This, in turn, may positively affect their sense of vulnerability (feeling safer and less lonely) and ethnic

prejudice (Graham, Munniksma, & Juvonen, 2014; Juvonen, Kogachi, & Graham, 2018), factors that could decrease bullying in schools. A recent study also shows that schools engaged in practices to promote inclusiveness and equity as a school program foster positive relationships between students (Rivas-Drake et al., 2019). Other recent research suggests that a positive classroom climate, for instance through student support, school as a community (connectedness), and cooperative learning, reduces the prevalence of bullying and victimization (Cornell et al., 2015; Fink et al., 2018; van Ryzin & Roseth, 2018). Although these findings are encouraging, more research on different classroom factors and their interplay is needed to help better understand the formation and development of peer relationships and social behaviors in childhood.

Focus on positive peer relations

Although Chapters four and five examined respectively friendship relationships and defending relationships, the focus in this thesis was on negative relationships (victim-bully relationships) in the classroom. Scholars recently started to investigate prosocial or helping relationships in the classroom (van Rijsewijk, 2018), which are more general types of positive relationships and may lead to the development of new friendships and possibly defending as well. Help networks that involve solving practical and emotional problems of students (e.g., with their homework or with their depressive symptoms) show some similarities with friendship networks, but only partly overlap and have distinct characteristics. For instance, help networks are less dense (have fewer ties) than friendship networks, consist of fewer mutual ties (where both students help each other), but are also mostly among same-sex classmates. Help networks also differ between classrooms in terms of structure: networks can be densely knit, such that every classmate helps another one, or they can be segmented such that helping occurs only incidentally in small separated groups in the classroom. Like defended victims, general help benefits specific others, such as low achievers and those who are rejected. An avenue for future research is to examine prosocial relations in childhood in schools with a clear philosophical background, such as Montessori or Jenaplan schools, as they stimulate prosocial behavior among children by encouraging the provision of help across the grades within the classroom, and to compare the findings from these schools with (stable) single-grade schools and unstable (unstable) administrative multigrade schools as they do not have such an explicit goal.

Networks in early childhood

Most social network research, not excluding the four studies in this thesis, focused on middle to late childhood or (early) adolescence (for a review: Veenstra et al., 2013). Not much is known about the networks of early elementary school children, mainly because it is difficult and time-consuming to capture their networks. Intensive longitudinal observational data

are needed to study interactions between young children. Nonetheless, children's peer relations develop rapidly when they first enter formal education, during this early period in childhood education, peer relations increasingly shape social behavior (Hawley, 1999).

Research in early childhood points in the direction that social networks of young children are structured in similar ways to that observed among older children (Huitsing & Monks, 2018; Kim & Park, 2018; Kiuru et al., 2017; Schaefer, Light, Fabes, Hanish, & Martin, 2010; Watling-Neal, Durbin, Gornik, & Lo, 2017). In the beginning of the school year, children become mutual friends in preschool classes and maintain mutual friends at the end of the school year. Some of these young children are more popular than others in their preschool classroom and receive more friendship nominations from others. Moreover, children tend to become friends of friends, indicating that they form friendship groups (Schaefer et al., 2010). Concerning aggression and defending processes, it was found that aggressive preschool children often are aggressive to other aggressive children, suggesting that young aggressors are less strategic than older children in targeting vulnerable children (Huitsing & Monks, 2018). Only one study investigated longitudinally the role of children's social networks on social behavior, and showed that peers influence children's levels of aggression and social status (Kim & Park, 2018). Apart from this study, no other research has investigated longitudinally the role of network processes in social behaviors in early childhood.

Networks in (early) adolescence

Research on peer relationships in (early) adolescence has increased exponentially over the past two decades, providing much insight into how relationships among adolescents develop over time (for a review: Brechwald & Prinstein, 2011). Most attention has been directed to the emergence and development of friendship relationships (for a review: Veenstra et al., 2013). However, friendships only represent a selective aspect of the adolescent peer ecology and adolescents can also be tied through negative relationships. A few studies investigated negative networks within a school context, most prominently dislike networks (e.g., Berger & Dijkstra, 2013; Pál et al., 2015; Rambaran et al., 2015). Bullying research could benefit from examining bullying, victimization, and defending networks in adolescence because bullying processes are likely to be different in adolescence than in childhood. The number of bullies increases or remains stable in early adolescence, whereas the number of victims decreases during this time (Nansel et al., 2001; Pellegrini & Long, 2002). This increase in bullying during early adolescence is followed by a decrease during mid- and late adolescence (Kretschmer et al., 2017), which suggests that victims are especially in a weak position in early adolescence when bullying peaks. Investigation of bullying networks in adolescence may be more complicated than in childhood because adolescents have more diverse social interactions with peers outside of the own school context. Besides school,

adolescent life for a large part takes place online, in their neighborhood, and at the sport club.

Individual-level factors

Inclusion of individual-level factors in this thesis was limited to sex and grade (age). It is likely that other individual factors are important as well, providing additional or even alternative explanations of victim-bully relationships and victim-defender relationships. For instance, in Chapter 2, physical appearance or physical strength might help to explain differences in children's social positions rather than their age (or grade). Peer perceived popularity is another important indicator of power (imbalance) to control or harm others (Salmivalli, 2010). Personality traits involving arrogance, exploitativeness, and impulsivity may also determine social dominance in bullying (Volk, Provenzano, Farrell, Dane, & Schulman, 2019). In Chapter 3, taking into account dispositional or behavioral characteristics of newcomers (e.g., being aggressive, withdrawn, previously victimized, having low acceptance or being in an isolated position) might have resulted in a more nuanced understanding of the effects of newcomers in terms of victimization in school. In Chapter 4, it is possible that friendship selection and influence processes among bullies are stronger when bullies are more popular; friendship selection and influence processes might have occurred when both victims are highly rejected. Finally, in Chapter 5, information about the characteristics of the victims and defenders might provide additional information about why defending relationships between victims and defenders are formed. By including other individual-level factors it would have been possible to understand under which circumstances bullying relations and defending relations are more likely to occur.

6.3 Concluding remarks

The classroom context is important for understanding children's interpersonal relationships. This thesis is a first step toward exploring the appropriateness of a social network approach in understanding the extent to which bullying, victimization, and defending relations depend on classroom factors. The findings from the four studies in this thesis suggest that the investigated classroom factors have a small impact on the occurrence and development of victim-bully relations and victim-defender relations. The findings indicate that bullying relations are not affected much by classroom composition (structure and stability). The findings highlight instead that bullying situations are the result of complex processes: victim-bully relations and victim-defender relations are mostly driven by the direct friendly relationship between children at school, underscoring the importance of incorporating peer factors to better understand bullying situations within the classroom

context. The findings from this thesis show that many children in elementary education are involved in bullying situations, either as bully or as victim. While the findings showed that bullies receive direct support for their bullying behavior, fortunately so do the victims: many of them received direct support from a defender. Nonetheless, bullying behavior and peer victimization is a persistent problem in childhood and continues to be a problem in adolescence. Understanding why bullying occurs and persists in some classrooms more than others should therefore be an ongoing effort of researchers.

Samenvatting

(Summary in Dutch)

Pesten is een complex sociaal probleem. In wetenschappelijk onderzoek wordt pesten doorgaans opgevat als "intentioneel en herhaaldelijk schade toebrengen aan één of meer personen die moeite hebben om zichzelf hiertegen te verdedigen". Cruciaal aan pesten is dat er sprake is van een ongelijke machtsverdeling tussen pester en slachtoffer. Pesten gebeurt op veel manieren, maar globaal onderscheiden we fysiek pesten (slaan of schoppen), verbaal pesten (uitlachen of uitschelden) en relationeel pesten (roddelen of buitensluiten).

Dat pesten een probleem vormt, wordt duidelijk als we naar de aantallen kijken. Gemiddeld genomen wordt ongeveer 30 procent van de basisschoolleerlingen soms gepest op school en 10 procent zelfs vaak. In Nederland zitten er in een klas van 25 leerlingen gemiddeld genomen ongeveer 2 à 3 frequente pestslachtoffers.

Veel slachtoffers van pesten hebben moeite met het maken en behouden van vriendschappen, ervaren gevoelens van angst en depressie in zowel de kindertijd als in de adolescentie en presteren onder hun kunnen. Sommige kinderen gaan niet langer naar school, omdat ze bang zijn om opnieuw gepest te worden. Bestaande antipestaanpakken laten wisselende succesen zien en werken niet voor alle slachtoffers even goed. Het is daarom van belang om beter te begrijpen hoe pesten ontstaat op school.

Dit proefschrift is erop gericht om meer inzicht te verkrijgen in de processen achter pesten en slachtofferschap van pesten in schoolklassen en de mate waarin klasfactoren een rol spelen bij het ontstaan en de ontwikkeling van pesten onder basisschoolleerlingen. In vier studies wordt de aandacht gericht op de school en daarbinnen de klas als sociale context voor pesten en slachtofferschap.

Pesten in combinatieklassen en reguliere klassen

Klassen in het Nederlandse basisonderwijs verschillen enorm als het gaat om de manier waarop ze zijn gestructureerd. Meestal zitten kinderen in een klas die voor het grootste gedeelte bestaat uit leeftijdsgenoten. Dit zijn reguliere klassen waarbij de leerlingen over het algemeen weinig van elkaar verschillen op gebied van sociale en cognitieve ontwikkeling. Het komt echter ook voor dat kinderen in een klas zitten waarbij de leerlingen juist van elkaar verschillen in leeftijd. Dit zijn combinatieklassen die bestaan uit ten minste twee verschillende leerjaren. Combinatieklassen ontstaan in de meeste gevallen uit noodzaak omdat er te weinig leerlingen zijn om enkele groepen te vormen (administratieve redenen), maar worden ook gevormd met als doel om sociale relaties en hulpgedrag tussen oudere leerlingen en jongere leerlingen te bevorderen (pedagogische redenen).

Wat de gevolgen zijn van de verschillende klassensamenstellingen voor het ontstaan van pesten tussen de kinderen in de klas is nog onduidelijk. Om die reden werd in **hoofdstuk 2** door middel van sociale-netwerkanalyse onderzocht of 1) combinatieklassen (met twee leerjaren in één klas) verschillen van reguliere klassen als het gaat om pesten, en 2) welke rol leeftijdverschillen hierin spelen. Voor de analyses werd gebruik gemaakt van een selectie van 26 klassen (656 leerlingen in groepen 5 tot en met 8) afkomstig uit de controlegroep van KiVa, een meerjarig project gericht op het terugdringen van pesten op basisscholen.

Resultaten uit het onderzoek in hoofdstuk 2 laten zien dat er onvoldoende ondersteuning is voor de gedachte dat kinderen in combinatieklassen die zijn gevormd om administratieve redenen beter of slechter af zijn dan kinderen in reguliere klassen als het gaat om betrokkenheid bij pesten. Er is geen aanwijsbaar verschil tussen beide type klassen in het niveau van pesten (percentage slachtoffers) en leeftijdsverschillen verhogen niet het risico op slachtofferschap in combinatieklassen (jongere kinderen in zulke klassen worden niet vaker gepest door oudere kinderen dan door hun eigen leeftijdsgenoten). De beschrijvende analyses (zonder te controleren voor andere factoren) lieten, zoals verwacht, wel zien dat er minder gepest wordt in combinatieklassen die zijn gevormd om pedagogische redenen.

Pesten in klassen met stabiele en wisselende klassensamenstelling

Op sommige basisscholen blijven de kinderen bij elkaar in de klas zitten als ze naar een nieuw leerjaar gaan. Door het combineren van klassen om administratieve of pedagogische redenen wisselt de klassensamenstelling op andere scholen elk jaar. Naast deze structurele wisselingen in de klassensamenstelling hebben scholen ook vaak te maken met incidentele veranderingen op individueel niveau, zoals zittenblijvers of kinderen die verhuizen en nieuw zijn op school. Deze wisselingen leiden tot instabiliteit in de klassensamenstelling.

Wat de gevolgen zijn van de wisselende klassensamenstellingen voor veranderingen in pesten tussen basisschoolleerlingen is onduidelijk. Om die reden werd in **hoofdstuk 3** door middel van sociale-netwerkanalyse onderzocht of 1) nieuwkomers een grotere risico lopen om gepest te worden, en 2) of kinderen in stabiele klassen slachtoffer worden van pesten als ze voor langere tijd bij elkaar in de klas zitten. Voor de analyses werd gebruik gemaakt van 31 KiVa controlescholen (3.254 leerlingen in groepen 4 tot en met 7) gemeten over drie leerjaren.

Resultaten uit het onderzoek in hoofdstuk 3 laten zien dat nieuwkomers meer risico lopen om gepest te worden in sommige instabiele scholen (met wisselende klassensamenstellingen). Daarentegen lopen kinderen in stabiele scholen (zonder wisselende klassensamenstellingen) juist meer risico om gepest te worden door leeftijdsgenoten die deel uitmaken van hetzelfde

leerjaar of dezelfde klas binnen het schooljaar, maar onverwacht niet door leerlingen bij wie ze voor langere tijd in de klas zitten (over verscheidene schooljaren; na rekening te houden met andere factoren).

Pesten in vriendschapsgroepen in de klas

Pesten in de klas is een proces waarbij verscheidene kinderen betrokken zijn. Zo kan het bijvoorbeeld zijn dat een leerling die anderen pest, geholpen wordt door "meelopers". Slachtoffers van pesten worden meestal door verscheidene kinderen tegelijk belaagd. Er zijn daarmee verschillende manieren waarop kinderen betrokken kunnen zijn bij het pesten: als initiator van pesten en als meeloper.

Centraal staat de sociale status in de groep. Zo hebben kinderen met weinig vrienden meestal een zwakke sociale status, wat hen kwetsbaar maakt om gepest te worden. Daarentegen krijgen pesters juist hulp van anderen. De gedachte is dat pesters andere kinderen meenemen in hun pestgedrag. Dit leidt ertoe dat zij sterker staan in de groep.

Ondanks theoretische argumenten dat pesten het resultaat is van een complex proces in de groep, blijft empirisch bewijs hiervoor in het basisonderwijs uit. Eerdere studies in het voortgezet onderwijs naar beïnvloeding van pestgedrag binnen vriendschappen lieten niet duidelijk zien dat kinderen die bevriend zijn met pestende kinderen zelf ook gaan pesten in de adolescentiefase. Een mogelijke oorzaak voor het ontbreken van een dergelijk effect is de manier waarop pesten doorgaans wordt onderzocht, namelijk als individueel kenmerk van kinderen terwijl pesten juist een relationeel karakter (*wie pest wie*) heeft waarbij pesters hun slachtoffers en vrienden strategisch kiezen. Om die reden werd in **hoofdstuk 4** door middel van sociale-netwerkanalyse onderzocht of 1) pesters met dezelfde slachtoffers vrienden worden (sociale selectie), en 2) of kinderen over tijd de slachtoffers van hun vrienden beginnen te pesten (sociale invloed). Voor de analyses werd gebruik gemaakt van 19 KiVa controleklassen (481 leerlingen in groepen 4 tot en met 7) met drie metingen in twaalf maanden tijd.

Resultaten uit het onderzoek in hoofdstuk 4 ondersteunen de visie op pesten als een groepsproces: op basisscholen selecteren pesters elkaar als vrienden en pesters zetten hun vrienden aan tot pesten. Er was geen ondersteuning voor selectie- en invloedprocessen onder slachtoffers in het basisonderwijs: slachtoffers met dezelfde pesters selecteren elkaar niet als vrienden (geen sociale selectie), en kinderen worden geen slachtoffer van de pesters van hun vrienden (geen sociale invloed of "besmetting").

Verdedigen in klassen waar veel gepest wordt

Verdedigers spelen een belangrijke rol bij het tegengaan van pesten. Ze hebben de mogelijkheid om de situatie voor slachtoffers aanzienlijk te verbeteren door direct in te grijpen, bijvoorbeeld door de pesters te confronteren met hun gedrag en daarmee het pesten te laten stoppen. Hiermee zorgen ze er tegelijkertijd voor dat slachtoffers zich beter voelen door minder last te hebben van gevoelens van angst en depressie en meer zelfvertrouwen te krijgen.

Hoewel de meeste kinderen het pesten afkeuren en slachtoffers van pesten graag willen helpen, blijft het verdedigen van slachtoffers vaak uit. Een veel gehoorde reden is dat mogelijke verdedigers, zogenaamde omstanders, bang zijn om zelf het slachtoffer te worden van pesten wanneer ze ingrijpen vooral in een omgeving waarin het pesten overheerst en pesten dus de norm is. Wel of niet overgaan tot verdedigen hangt van meer af dan individuele factoren en klasfactoren. De sociale band die kinderen hebben met het slachtoffer speelt mogelijk ook een belangrijke rol: hebben ze een positieve of negatieve relatie met het slachtoffer?

Eerder onderzoek naar de rol van klassennormen bij verdedigen van slachtoffers maakte vooral gebruik van een individuele benadering. Hiermee verliezen we waardevolle informatie over het relationele karakter van verdedigen (*wie verdedigt wie*). Om die reden werd in **hoofdstuk 5** gekozen voor zowel een individuele als een sociale-netwerkbenadering om de invloed van sociale relaties en de rol van pestnormen bij het overgaan tot verdedigen te bepalen. Voor de analyses werd gebruik gemaakt van een selectie van 48 klassen (1.272 leerlingen, allemaal in groep 7) afkomstig uit de voormeting van KiVa (voordat de interventie werd ingezet).

Resultaten van de individuele benadering met multilevel Poisson regressie laten zien dat kinderen die leuker gevonden worden door slachtoffers hen meer verdedigen en dat dit sterker het geval was in een klas waarin pesten meer voorkomt. Daarnaast laten de resultaten van de sociale-netwerkanalyses zien dat kinderen slachtoffers verdedigen die hen leuk vinden maar niet die hen niet leuk vinden. Er waren geen aanwijzingen dat dit sterker of minder sterk het geval was in een klas waarin pesten meer voorkomt.

Praktische implicaties

Op basis van de vier studies kan een aantal conclusies worden getrokken over de invloed van de onderzochte klasfactoren bij het ontstaan en de ontwikkeling van pesten tussen leerlingen op de basisschool. Deze conclusies hebben ook praktische implicaties.

Zijn kinderen beter af in reguliere klassen dan in combinatieklassen? Veel ouders worstelen met een dergelijke vraag wanneer ze van de school te horen krijgen dat hun kind volgend jaar in een combinatieklas terechtkomt. Eerder onderzoek liet geen verschillen zien tussen combinatieklassen en reguliere klassen op gebied van sociale en cognitieve ontwikkeling van kinderen. De resultaten uit dit proefschrift bieden ook geen ondersteuning voor de gedachte dat jongere kinderen in combinatieklassen meer risico lopen gepest te worden door oudere kinderen. Er zijn geen aanwijzingen dat kinderen beter of slechter af zijn in combinatieklassen dan in reguliere klassen.

Pakken wisselende klassensamenstellingen gunstig of ongunstig uit? Jaarlijks worstelen veel scholen met het vormen van klassen van gelijke leerlingaantallen. Dit komt het vaakst voor bij scholen die groepen of klassen combineren vanwege administratieve redenen, waar te weinig leerlingen zijn om reguliere klassen te vormen. De resultaten uit dit proefschrift laten geen aantoonbaar verschil zien in de totstandkoming van pestrelaties tussen scholen die klassen mengen ("instabiele scholen") en scholen die dat niet doen ("stabiele scholen"). Hoewel er aanwijzingen waren dat nieuwkomers in instabiele scholen eerder gepest worden en kinderen in stabiele scholen vaker gepest worden door klas- of jaargenoten, wegen deze factoren niet op tegen andere factoren die het pesten verklaren, zoals de dichtheid van het netwerk. Het is ook de vraag of het mengen van klassen tot negatieve uitkomsten kan leiden, zoals verbreken van vriendschappen tussen leerlingen. Toekomstig onderzoek moet dit uitwijzen.

Is pesten het resultaat van een groepsproces? Hoewel eerdere onderzoeken in de adolescentie geen duidelijke ondersteuning vonden voor selectie- en invloedprocessen bij pesten, laten de resultaten uit dit proefschrift zien dat in de kindertijd pesters vrienden worden (selectie) en dat pesters hun vrienden aanzetten tot pesten (invloed). Deze resultaten tonen aan dat leeftijdsgenoten ("peers") een belangrijke rol spelen bij pesten. Pesters richten zich op specifieke slachtoffers die zich moeilijk weten te verweren en zoeken tegelijkertijd steun bij klasgenoten die meedoen in hun pestgedrag. Met de inzichten verkregen uit dit proefschrift kunnen scholen en leerkrachten beter geinformeerd worden over de sociale processen achter pesten om zo het pesten in de klas tegen te gaan.

Worden omstanders ontmoedigd om te interveniëren in pesten? Als een groot deel van de klas meedoet, wordt pesten de norm in een klas. Voorgaand onderzoek laat zien dat in zulke klassen pesters meer worden geaccepteerd door klasgenoten terwijl kinderen die niet meedoen met pesten of gepest worden juist sterk worden afgewezen door klasgenoten. Dit vormt mogelijk ook een reden waarom in klassen waar pesten veel voorkomt kinderen minder vaak opkomen voor slachtoffers door hen te verdedigen, omdat ze bang zijn afgewezen te

worden of erger nog zelf het slachtoffer worden van pesten. De resultaten uit dit proefschrift laten zien dat wanneer slachtoffers een positieve band hebben met klasgenoten zij eerder verdedigd worden, zelfs in een klas waarin pesten veel voorkomt. Deze bevindingen bieden aanknopingspunten voor scholen om pesten tegen te gaan door aandacht te besteden aan het ontwikkelen van positieve relaties (bijvoorbeeld vriendschappen of samenwerken) tussen slachtoffers en mogelijke verdedigers (omstanders).

Supplements Chapter 2

List of supplements:

S2.1 Results of the goodness of fit statistics

S2.2 Forest plots of results of the separate classroom ERGM analysis

S2.1 Results of goodness of fit statistics.

The results of the goodness of fit (GoF) statistics for each classroom victimization network model is presented in S2.1.1 and summarized in S2.1.2. The majority of the classroom victimization networks were adequately modeled by the effects reported in Table 2.4. This means no additional network or individual effects in the model were needed to capture the relational patterns in these victimization networks, most likely because victimization networks are sparse networks. Accordingly, a small set of network effects suffices (referring to density, sinks, isolates, in-ties spread, multiple two-paths, and shared in-ties; see Huitsing et al., 2012; see also Huitsing & Veenstra, 2012).

In one classroom (3), the GoF statistics indicated that reciprocity was not captured adequately. In addition, in almost half of the classrooms (1, 7, 8, 9, 12, 13, 15, 18, 20, 23, 24, 26) the GoF statistics indicated that reciprocity with regard to age (in various forms, referring to sum, difference, product) was not modeled adequately. However, these configurations were only present in four of these classrooms (7, 8, 12, 23). Such configurations were not related to one particular effect, and because we already included non-reciprocal age-related effects to test our hypothesis, we decided not to include these extra effects.

S2.1.1 Overview of goodness of fit (t) statistics for each classroom victimization network model seperately included in this study.

Classroom	1	2	3	4	5	6	7	8	9	10	11	12	13
Network effects													
Arc	0.00	0.06	-0.02	-0.08	0.01	0.12	0.03	0.00	-0.20	0.02	-0.02	-0.05	-0.03
Reciprocity	-0.08	1.38	2.03	-0.43	0.72	2.01	0.54	1.00	-0.63	-0.12	-0.24	0.14	-0.09
2-In-Star	0.36	0.11	0.18	-0.15	0.22	0.08	0.06	-0.11	-0.16	0.67	-0.16	-0.12	-0.12
2-Out-Star	-0.29	0.07	-0.09	0.16	0.00	0.10	0.02	0.02	-0.14	-0.25	-0.04	-0.10	-0.05
3-In-Star	-0.17	0.15	0.37	-0.27	0.61	-0.02	0.21	-0.39	-0.36	-0.13	-0.37	-0.22	-0.26
3-Out-Star	-0.45	-0.03	-0.23	0.50	-0.15	0.09	-0.08	-0.06	-0.24	-0.42	-0.13	-0.19	-0.16
Mixed-2-Star	-0.49	-0.01	-0.04	-0.13	-0.01	0.10	0.02	-0.03	-0.18	-0.54	-0.05	-0.09	-0.30
030T	-0.10	0.63	0.18	1.04	-0.49	0.70	0.35	-0.01	0.73	-0.23	-0.50	-0.18	-0.24
030C	-0.05	-0.23	-0.21	-0.13	-0.03	0.75	-0.39	0.40	-0.10	-0.03	-0.06	-0.28	-0.05
Sink	-0.03	0.03	-0.05	-0.13	0.01	0.01	0.02	-0.06	-0.19	-0.02	0.01	0.00	-0.01
Source	0.28	0.10	-0.23	0.13	-0.57	-0.06	-0.21	0.65	-0.02	0.43	0.11	0.24	0.24

S2.1.1 Continued.

Classroom	1	2	3	4	5	6	7	8	9	10	11	12	13
Isolates	0.02	-0.04	0.02	0.12	0.01	-0.09	-0.05	0.04	0.22	0.02	0.01	0.04	0.02
K-In-Star	0.44	0.08	0.02	-0.06	-0.01	0.12	0.01	0.00	-0.15	0.74	-0.03	-0.05	-0.03
K-Out-Star	-0.18	0.09	-0.06	-0.01	0.06	0.10	0.04	0.01	-0.12	-0.13	-0.01	-0.05	-0.01
K-L-Star	-0.53	-0.01	0.00	-0.26	0.14	0.28	0.06	-0.20	-0.13	-0.60	-0.10	-0.07	-0.46
K-1-Star	-0.49	0.27	-0.19	-0.59	0.04	0.14	0.23	0.02	-0.26	-0.55	-0.04	-0.06	-0.38
1-L-Star	-0.53	-0.25	0.16	0.36	0.08	0.26	-0.14	-0.26	0.01	-0.58	-0.04	-0.05	-0.36
TK-Triangle	-0.10	0.72	0.20	1.19	-0.49	0.73	0.28	0.08	0.75	-0.23	-0.50	-0.15	-0.26
CK-Triangle	-0.05	-0.23	-0.21	-0.13	-0.03	0.90	-0.40	0.40	-0.10	-0.03	-0.06	-0.29	-0.05
DK-Triangle	-0.10	0.78	0.23	0.19	-0.49	0.66	0.38	0.12	0.73	-0.23	-0.47	-0.14	-0.28
UK-Triangle	-0.10	0.41	0.20	1.41	-0.49	0.76	0.37	-0.03	0.65	-0.23	-0.49	-0.15	-0.28
TK-2-Paths	-0.49	0.03	-0.03	-0.09	0.00	0.11	0.01	0.01	-0.14	-0.54	-0.02	-0.05	-0.31
DK-2-Paths	-0.29	0.07	-0.04	-0.09	0.04	0.11	0.01	0.00	-0.13	-0.24	0.00	-0.05	-0.02
UK-2-Paths	0.37	0.11	0.22	-0.35	0.29	0.10	-0.04	-0.12	-0.16	0.68	-0.15	-0.08	-0.08
Age effects													
Sender	-0.05	0.03	-0.03	-0.09	-0.02	0.06	-0.10	0.01	0.19	0.03	0.09	0.02	0.03
Receiver	0.00	-0.07	0.04	0.02	-0.02	0.14	0.05	-0.04	0.07	-0.03	0.04	0.06	0.05
Single-Sum	-0.03	-0.04	0.00	-0.06	-0.04	0.12	-0.08	0.00	0.22	0.01	0.12	0.04	0.04
Single-Difference	-0.01	-0.08	0.82	0.19	-0.10	0.31	-0.42	0.12	-0.40	-0.32	0.39	-0.14	-0.18
Single-Product	-0.72	-0.04	-2.13	-0.25	-0.57	0.69	0.40	-0.67	-0.40	0.98	-0.52	-0.19	0.02
Mutual-Sum	1.45	-0.39	-0.08	0.10	-1.46	-1.21	-1.31	1.35	1.64	-2.33	-0.81	-0.96	-1.42
Mutual-Difference	1.51	-1.75	-1.98	-1.67	-2.54	-1.55	-0.18	-0.17	-1.49	-1.67	-1.47	2.28	-1.54
Mutual-Product	-1.41	1.75	3.41	1.60	1.87	1.06	-1.15	1.06	0.85	0.20	-0.58	-1.41	1.78
Relative Difference	-0.03	0.06	-0.05	-0.10	0.00	-0.12	-0.11	0.03	0.16	0.04	0.01	-0.07	0.00
Gender effects													
Boy-Boy	0.88	1.27	1.93	4.00	0.02	1.13	0.50	-0.03	6.39	1.32	0.25	1.13	0.03
Girl-Girl	0.03	-0.05	0.02	-1.26	0.05	0.10	-0.85	0.00	-1.51	-0.01	-0.92	-0.99	-0.04
Girl-Boy	0.00	0.08	-0.02	-0.06	-0.02	0.12	0.04	0.00	-0.20	-1.09	-0.01	-0.06	-0.01
Boy-Girl	-0.79	-1.42	-1.63	-0.52	-0.05	-1.39	0.00	0.02	-0.84	0.01	0.00	-0.08	-0.03
Grade effects													
Low-Low	--	--	--	--	--	--	--	--	--	--	--	-0.05	0.73
High-High	--	--	--	--	--	--	--	--	--	--	--	-0.07	-0.06
Low-High	--	--	--	--	--	--	--	--	--	--	--	-0.04	-0.54
High-Low	--	--	--	--	--	--	--	--	--	--	--	0.01	0.02

S2.1.1 Continued.

Classroom	14	15	16	17	18	19	20	21	22	23	24	25	26
Network effects													
Arc	-0.05	-0.02	0.00	0.05	0.05	-0.18	0.03	-0.08	-0.01	-0.04	0.01	0.04	0.00
Reciprocity	1.22	-0.75	-0.40	0.06	-0.27	0.06	-0.68	-0.38	-0.08	0.59	-0.25	-0.25	-0.03
2-In-Star	0.05	-0.05	-0.19	0.11	0.03	-0.22	-0.14	-0.10	-0.18	0.16	0.36	-0.01	-0.02
2-Out-Star	0.01	0.03	0.40	0.06	-0.02	-0.20	0.05	-0.09	-0.35	0.12	-0.05	-0.02	0.21
3-In-Star	0.36	-0.15	-0.51	0.24	0.07	-0.35	-0.48	-0.12	-0.43	0.56	-0.28	-0.09	-0.19
3-Out-Star	-0.20	-0.04	0.53	-0.08	-0.11	-0.33	-0.03	-0.16	-0.47	0.09	-0.29	-0.13	0.17
Mixed-2-Star	-0.05	-0.03	0.00	0.05	-0.02	-0.22	-0.01	-0.10	-0.56	-0.11	-0.76	0.00	-0.30
030T	0.51	-0.06	-0.77	0.15	-0.21	-0.49	0.19	-0.05	-0.31	0.45	-0.24	0.14	-0.19
030C	-0.48	-0.47	-0.10	-0.35	-0.05	-0.55	-0.33	-0.30	-1.00	-0.42	-0.08	-0.18	-1.00
Sink	0.03	0.01	-0.05	0.03	0.05	-0.05	0.04	-0.02	-0.01	-0.01	0.01	0.07	-0.03
Source	-0.09	-0.15	0.37	-0.15	0.06	-0.38	0.59	-0.22	0.31	-0.20	0.61	0.00	0.01
Isolates	0.03	0.04	0.02	-0.05	-0.04	0.18	-0.02	0.05	0.00	0.03	0.01	-0.06	0.07
K-In-Star	-0.05	-0.02	0.00	0.04	0.01	-0.17	0.02	-0.10	-0.01	-0.05	0.55	0.03	0.08
K-Out-Star	0.15	0.03	0.25	0.11	0.04	-0.13	0.07	-0.02	-0.22	0.05	0.00	0.04	0.19
K-L-Star	-0.09	-0.12	-0.18	0.16	0.08	-0.36	-0.03	0.01	-0.63	-0.16	-0.83	0.20	-0.38
K-1-Star	-0.16	0.10	-0.39	0.11	-0.06	-0.17	-0.17	0.05	-0.59	0.13	-0.79	0.17	-0.35
1-L-Star	0.01	-0.23	0.38	0.34	0.10	-0.26	0.17	0.01	-0.59	-0.42	-0.79	0.03	-0.33
TK-Triangle	0.48	-0.11	-0.79	0.23	-0.19	-0.49	0.24	-0.02	-0.31	0.65	-0.24	0.19	-0.19
CK-Triangle	-0.49	-0.49	-0.10	-0.38	-0.05	-0.57	-0.33	-0.31	-1.00	-0.43	-0.08	-0.19	-1.00
DK-Triangle	0.47	-0.02	-0.79	0.14	-0.17	-0.49	0.24	-0.07	-0.31	0.40	-0.24	0.28	-0.20
UK-Triangle	0.55	-0.17	-0.79	0.13	-0.19	-0.51	0.06	0.05	-0.31	0.22	-0.24	0.21	-0.19
TK-2-Paths	-0.05	0.01	0.03	0.08	0.02	-0.19	0.04	-0.09	-0.57	-0.01	-0.76	0.01	-0.30
DK-2-Paths	-0.07	-0.01	-0.01	0.07	0.07	-0.19	0.06	-0.08	-0.34	-0.04	-0.04	0.04	0.25
UK-2-Paths	-0.17	-0.11	-0.55	0.18	0.15	-0.22	-0.14	-0.08	-0.16	-0.01	0.38	0.05	-0.01
Age effects													
Sender	0.01	0.00	-0.01	-0.03	-0.04	0.08	-0.01	0.14	-0.01	0.02	-0.07	-0.03	-0.01
Receiver	0.08	0.04	-0.01	-0.06	0.05	0.16	-0.05	0.05	-0.01	0.01	0.10	0.07	0.01
Single-Sum	0.04	0.02	-0.02	-0.05	-0.01	0.13	-0.02	0.11	-0.02	0.02	0.04	0.02	0.00
Single-Difference	-0.64	-0.51	-0.16	-0.30	-0.15	-0.46	0.24	-0.41	-0.47	-0.60	-0.85	0.22	-0.43
Single-Product	0.10	0.21	-0.13	0.17	0.66	0.12	-0.04	0.09	0.36	0.15	0.91	-0.24	-0.01
Mutual-Sum	1.74	0.82	0.65	1.03	-0.90	-1.63	0.87	2.62	-1.16	1.82	-0.01	-0.73	-2.27
Mutual-Difference	-0.32	-0.16	-1.09	-0.46	0.32	0.68	1.32	2.43	-2.76	-1.66	-0.59	1.29	-2.68
Mutual-Product	-1.75	-1.19	0.48	-0.91	0.45	-0.56	-0.14	-2.45	2.45	0.07	0.26	0.74	3.09
Relative Difference	-0.04	-0.03	-0.01	0.06	-0.08	-0.09	0.04	0.12	0.00	0.01	-0.11	-0.07	-0.02

S2.1.1 Continued.

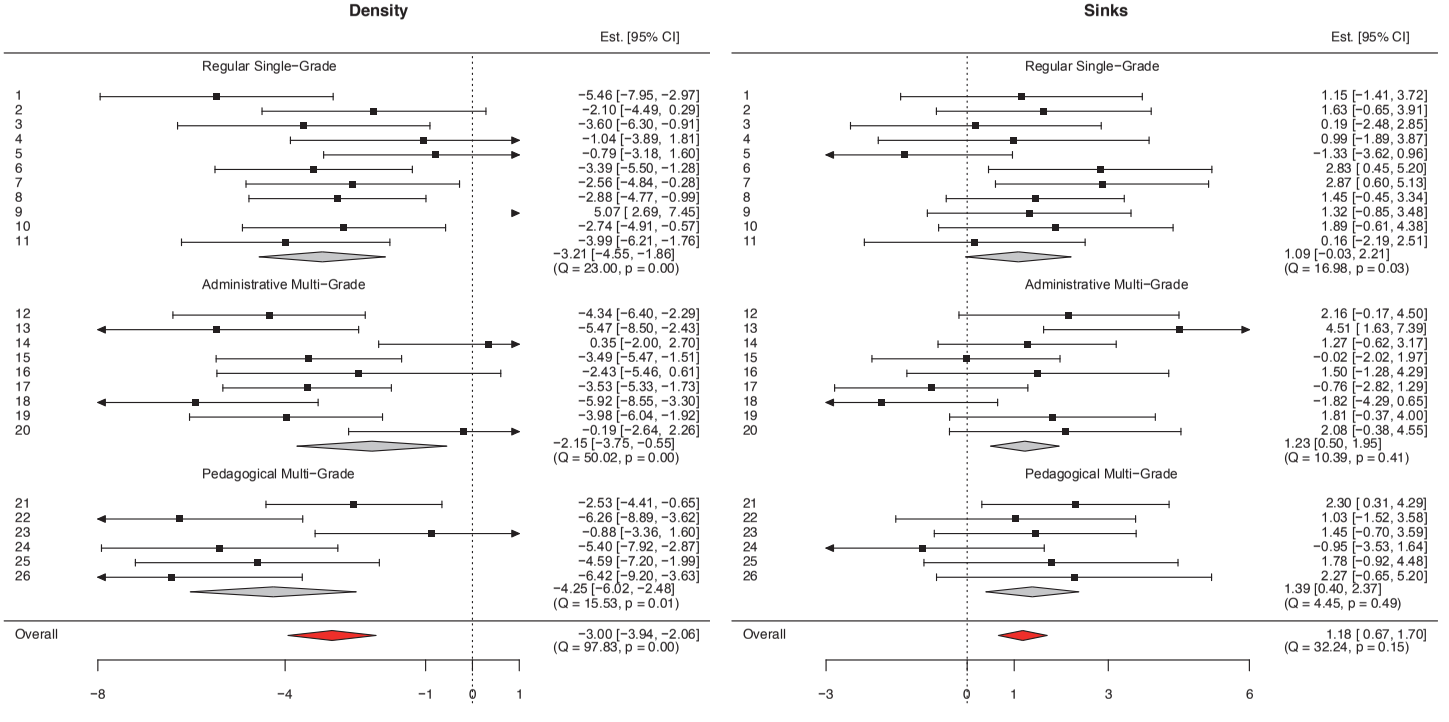
Classroom	14	15	16	17	18	19	20	21	22	23	24	25	26
Gender effects													
Boy-Boy	0.00	0.43	0.99	0.04	1.22	-0.20	-0.01	-0.08	-0.01	-0.05	1.29	0.02	1.71
Girl-Girl	-0.06	-1.26	0.04	0.03	0.02	-0.08	-0.01	-0.02	-0.04	-0.03	-0.67	0.04	0.09
Girl-Boy	-0.04	0.00	0.05	0.04	0.03	-0.12	0.05	-0.06	0.02	0.00	0.03	0.04	-0.04
Boy-Girl	-0.01	0.01	-0.98	0.05	-1.36	-0.18	0.06	-0.07	-0.01	-0.02	-0.91	0.02	-1.12
Grade effects													
Low-Low	-0.04	0.03	1.39	0.02	0.01	0.89	0.02	-0.09	1.25	1.63	0.04	0.03	1.60
High-High	0.04	0.00	-0.02	0.08	0.03	-0.82	0.02	0.00	-0.64	-0.01	-0.12	0.02	0.04
Low-High	-0.06	-0.08	0.03	0.06	0.00	-0.17	0.00	-0.10	-0.03	-1.37	-0.04	0.05	0.03
High-Low	0.00	0.02	-0.81	0.02	0.05	-0.18	0.02	-0.02	-0.76	-0.02	0.05	0.03	-1.01

Notes. The table shows the t-statistics for assessment of goodness of fit for each effect included and not included in the model. The t-statistic is calculated with (observation - sample mean) / standard deviation.

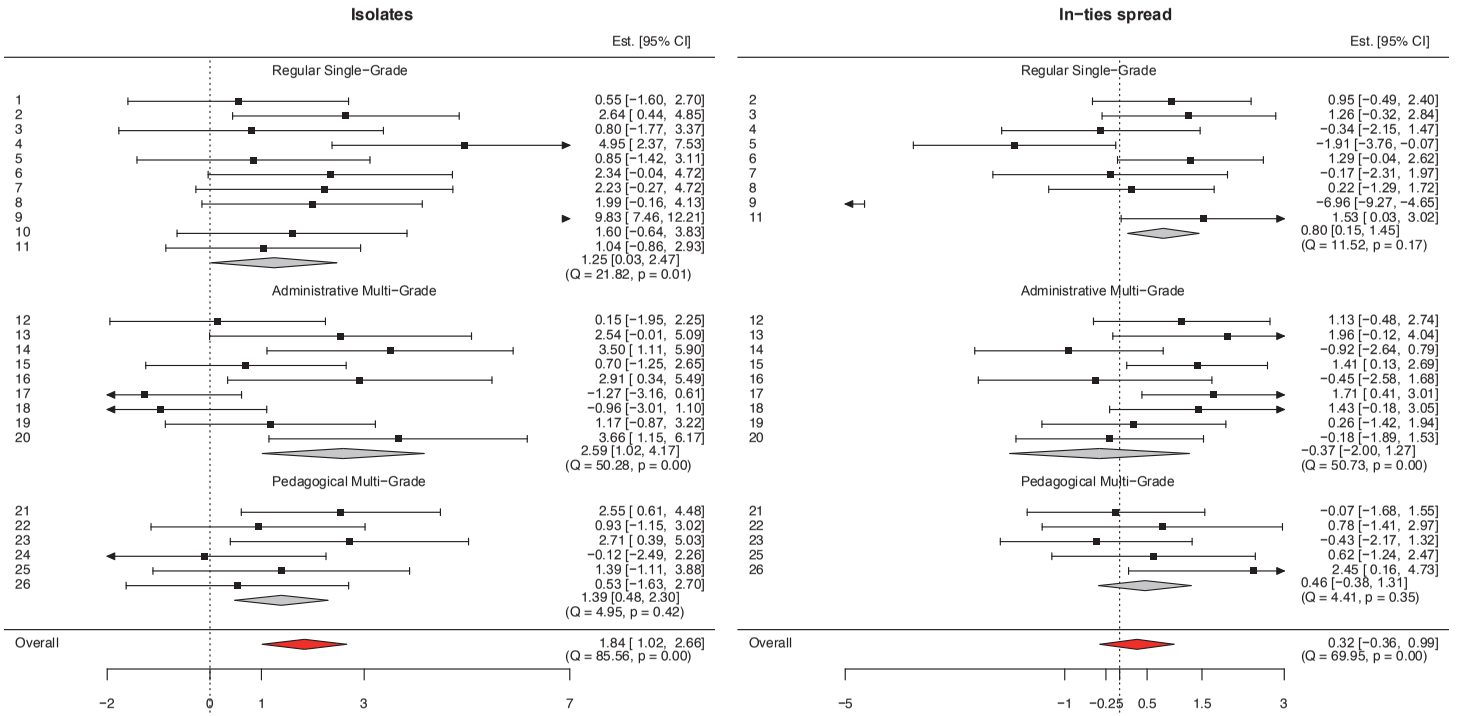
S2.1.2 Summary of goodness of fit results.

11 Regular single-grade classrooms	9 Administrative multigrade classrooms	6 Pedagogical multigrade classrooms	Summary/conclusion
9 classrooms showed good fit statistics.[a]	8 classrooms showed good fit statistics.[a]	5 classrooms showed good fit statistics.[a]	The majority of victimization networks were adequately modeled by included effects.
2 classrooms (3 and 6) showed poor fit on reciprocity effect.			Reciprocity ($i \leftrightarrow j$) was not adequately modeled in two classrooms. Because there are a few of such ties in these classrooms, it was not modeled explicitly.
3 classrooms (3, 5, and 10) showed poor fit on the mutual age-sum/product effect.	1 classroom (12) showed poor fit on the mutual age sum/difference effect.	3 classrooms (21, 22, and 26) showed poor fit on the mutual age sum/ product effect.	Reciprocity with regard to age effects was not adequately modeled in several classrooms. Because we already included non-reciprocal age effects, and it was not related to one particular age effect, no additional age effects were included.

Notes. [a]Good/acceptable fit is indicated by t-statistics lower than 2 in absolute terms for effects not included in the model.

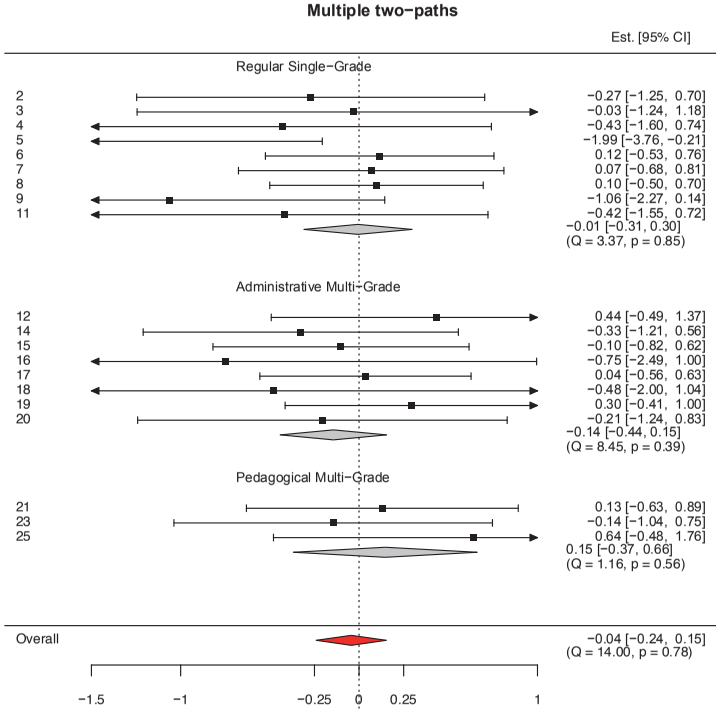


S2.2 Forest plots of results of the separate classroom ERGM analysis.



S2.2 Continued.

Supplements



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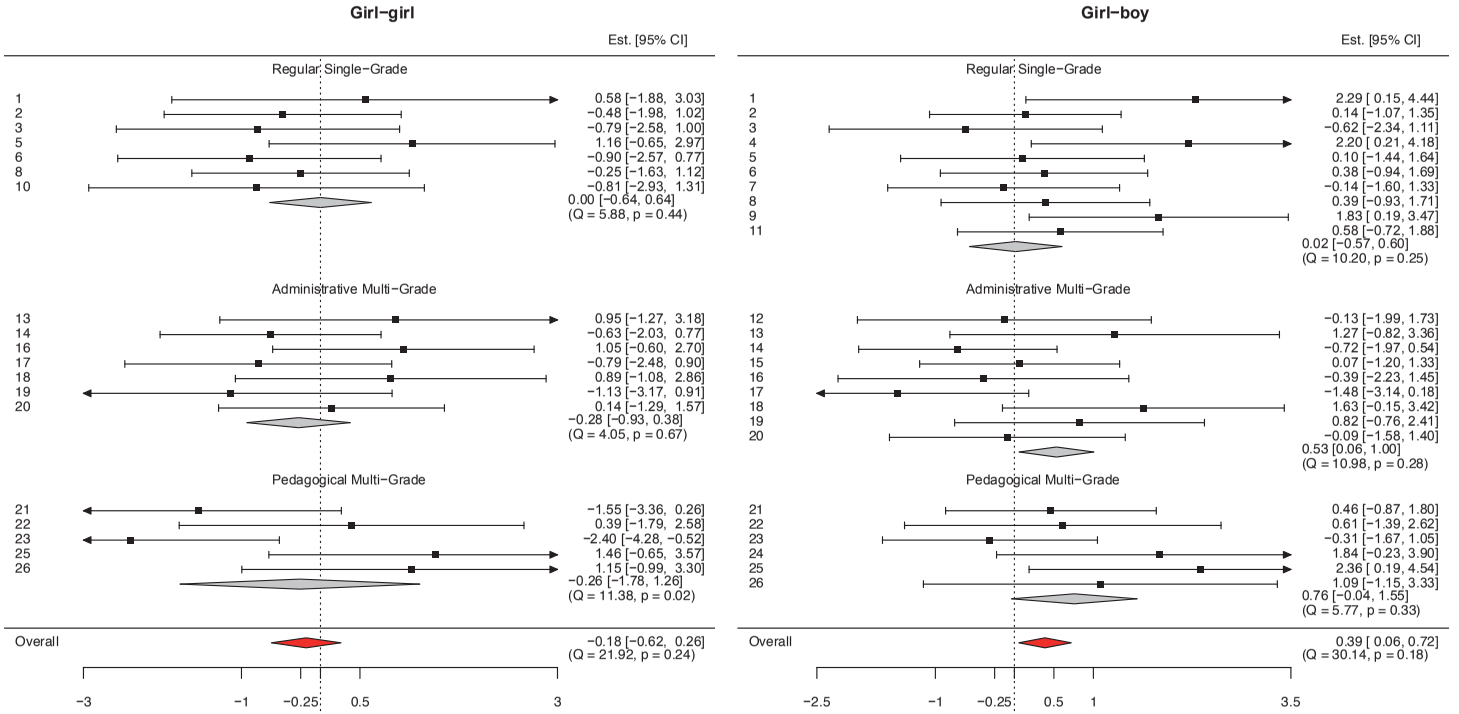
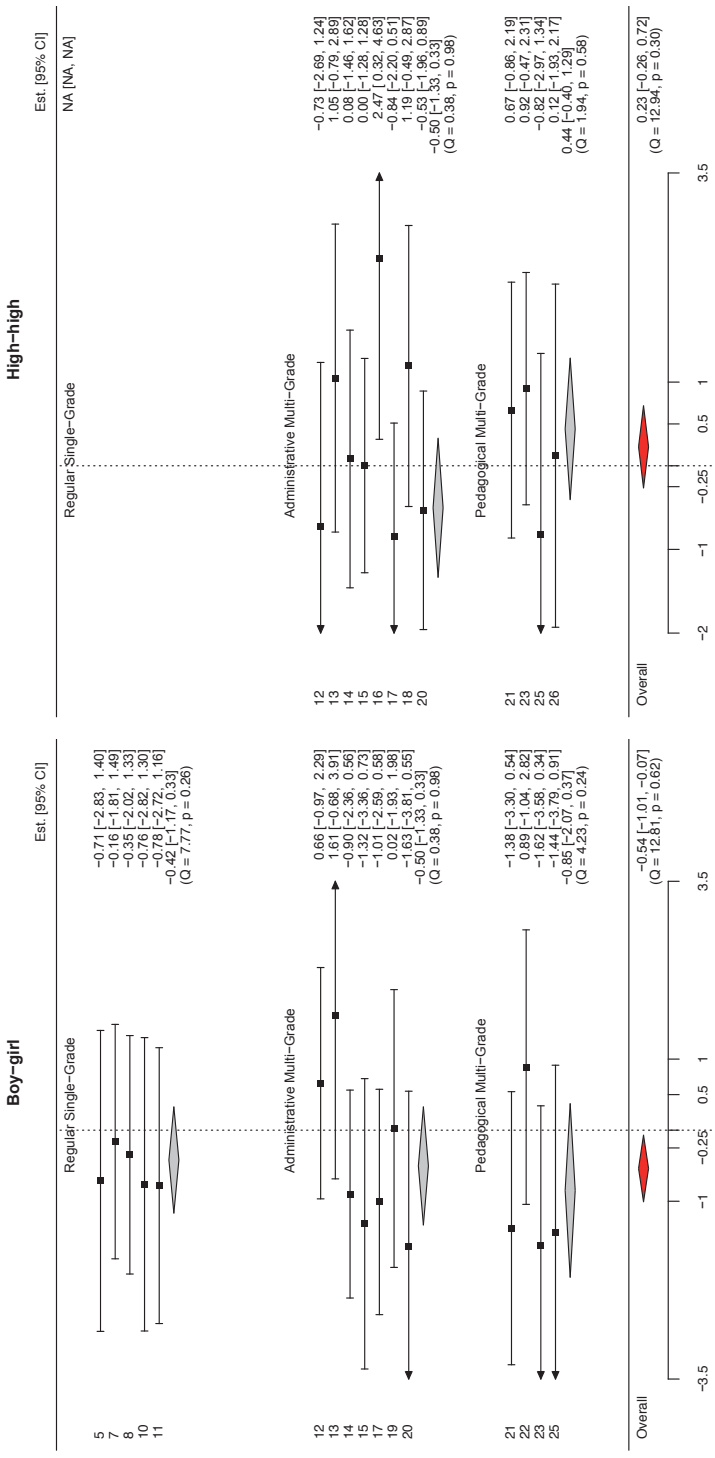


S2.2 Continued.

Supplements



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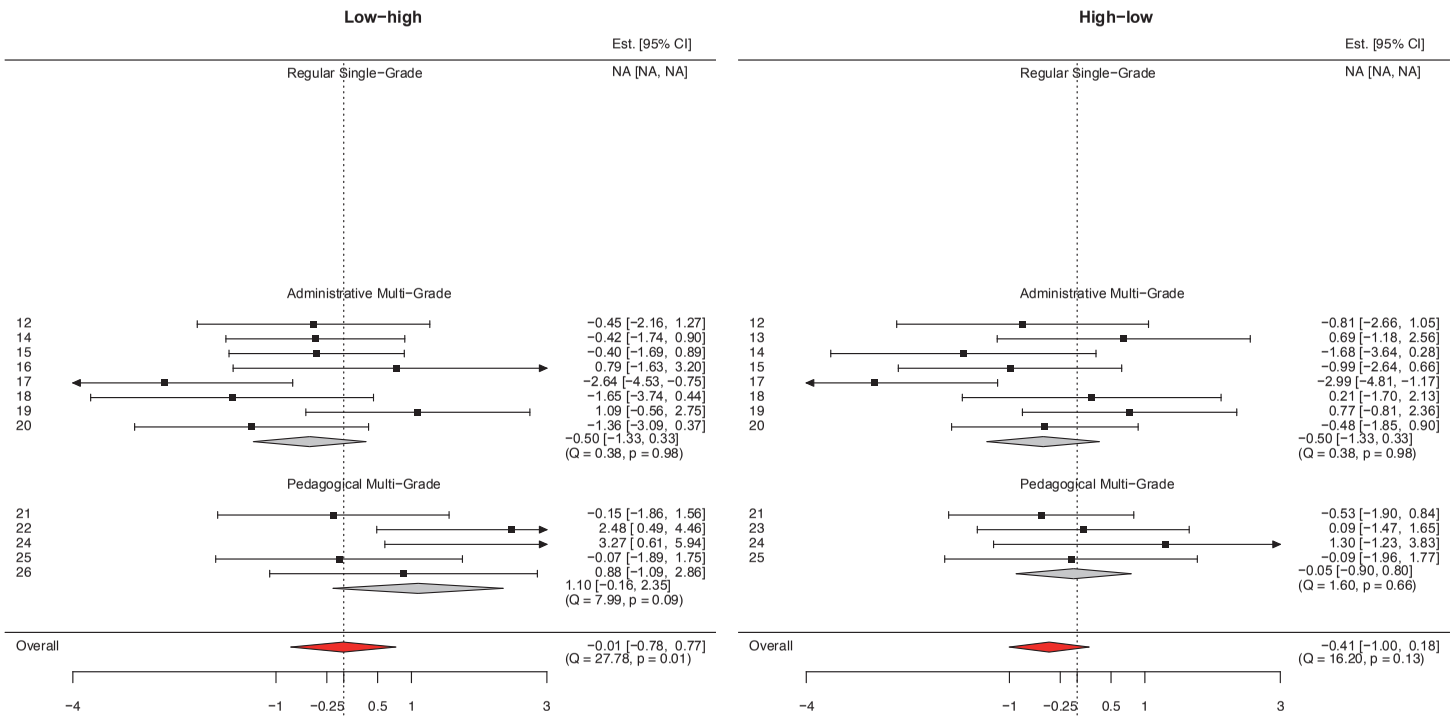
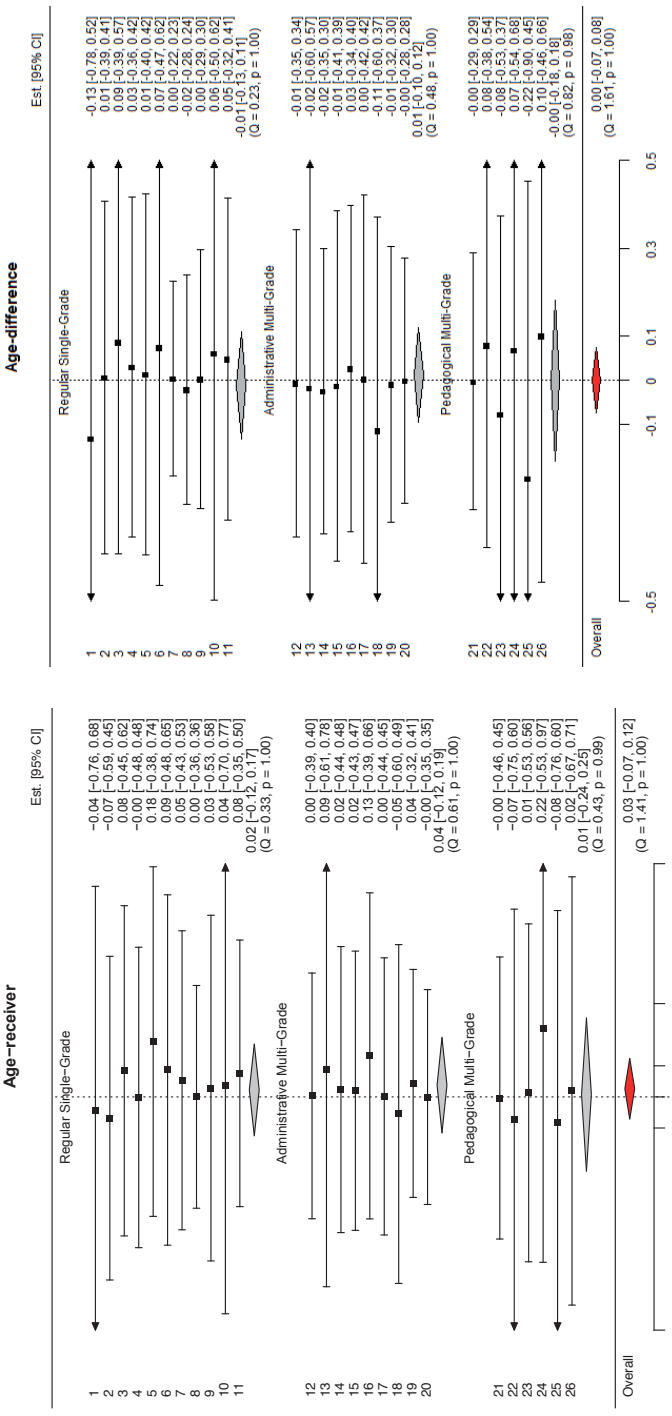


S2.2 Continued.

Supplements



S2.2 Continued.

Supplements Chapter 3

List of supplements:

S3.1 Visualization of the goodness of fit for each school

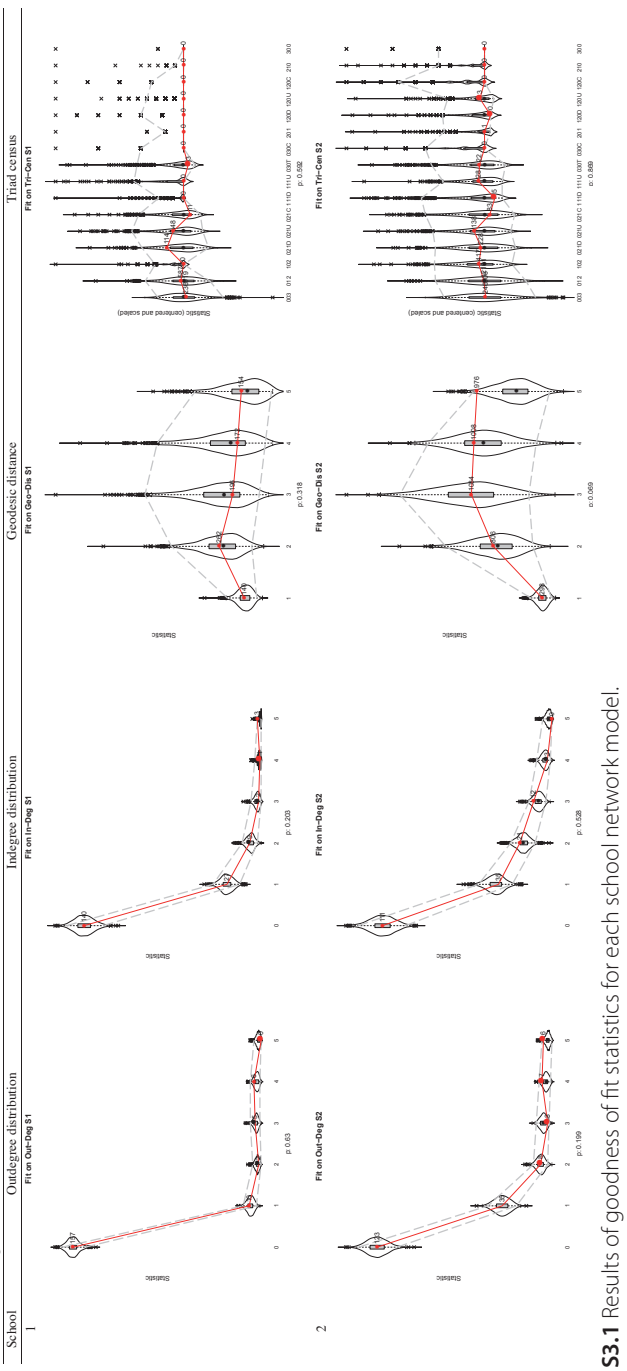
S3.2 Overview of the descriptive statistics for each school summarized in Table 3.1

S3.3 Meta-analysis of school-wide victimization networks without controlling for school size

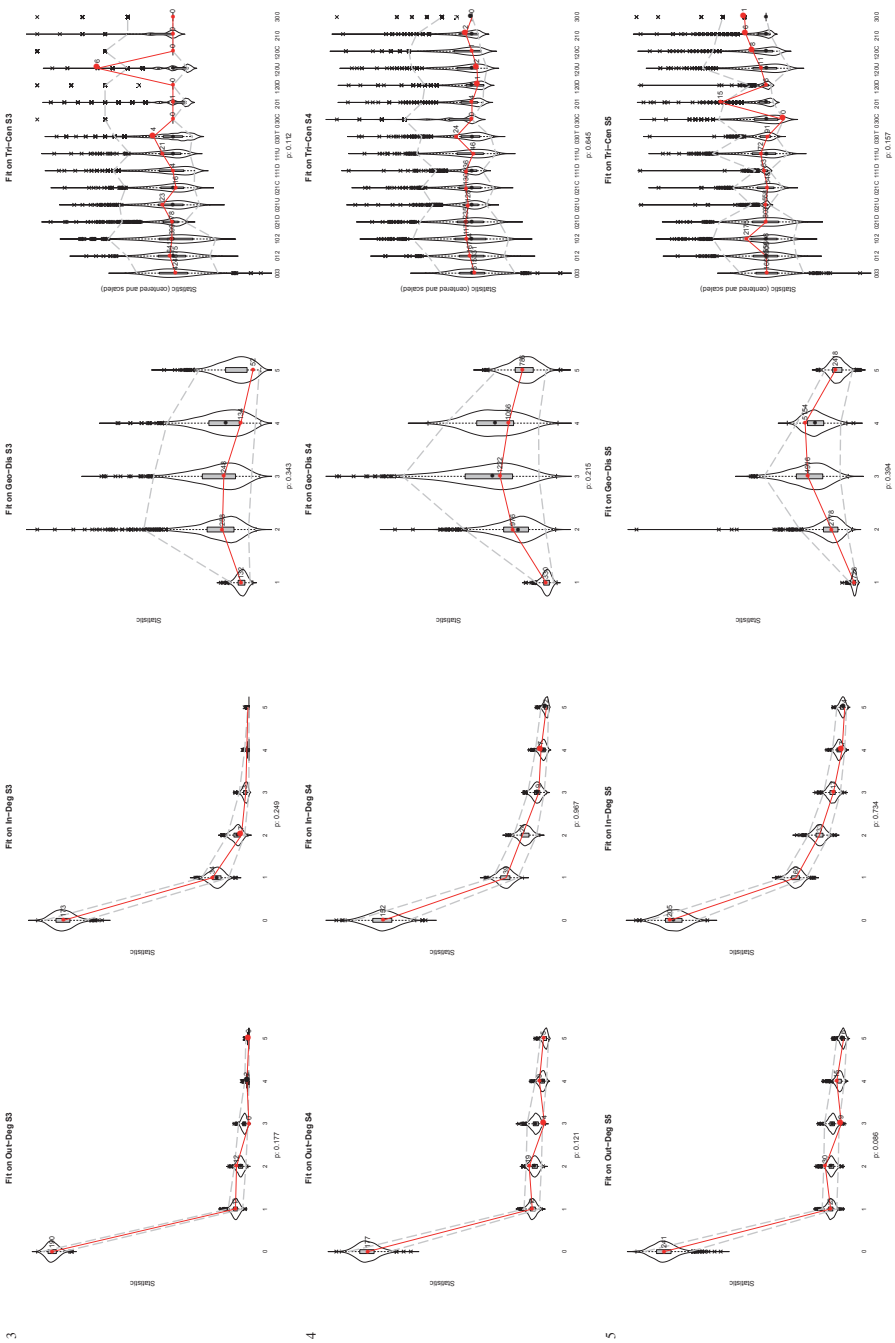
S3.4 Forest plots of results summarized for all schools and for three school types

S3.5 Meta-analysis of school-wide victimization networks with the same model specification

S3.6 Relative contribution of effects contributing to peer victimization



S3.1 Results of goodness of fit statistics for each school network model.



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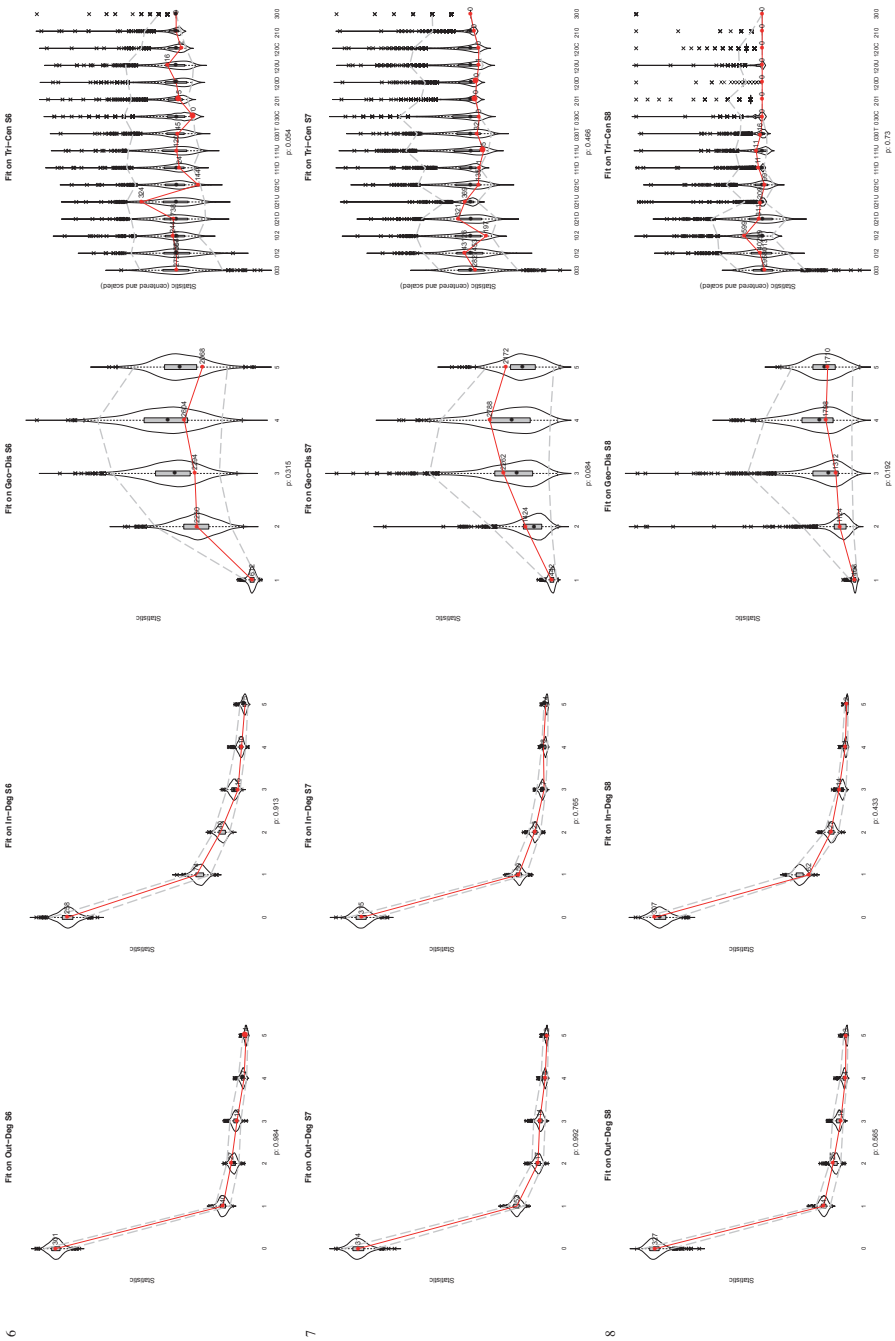

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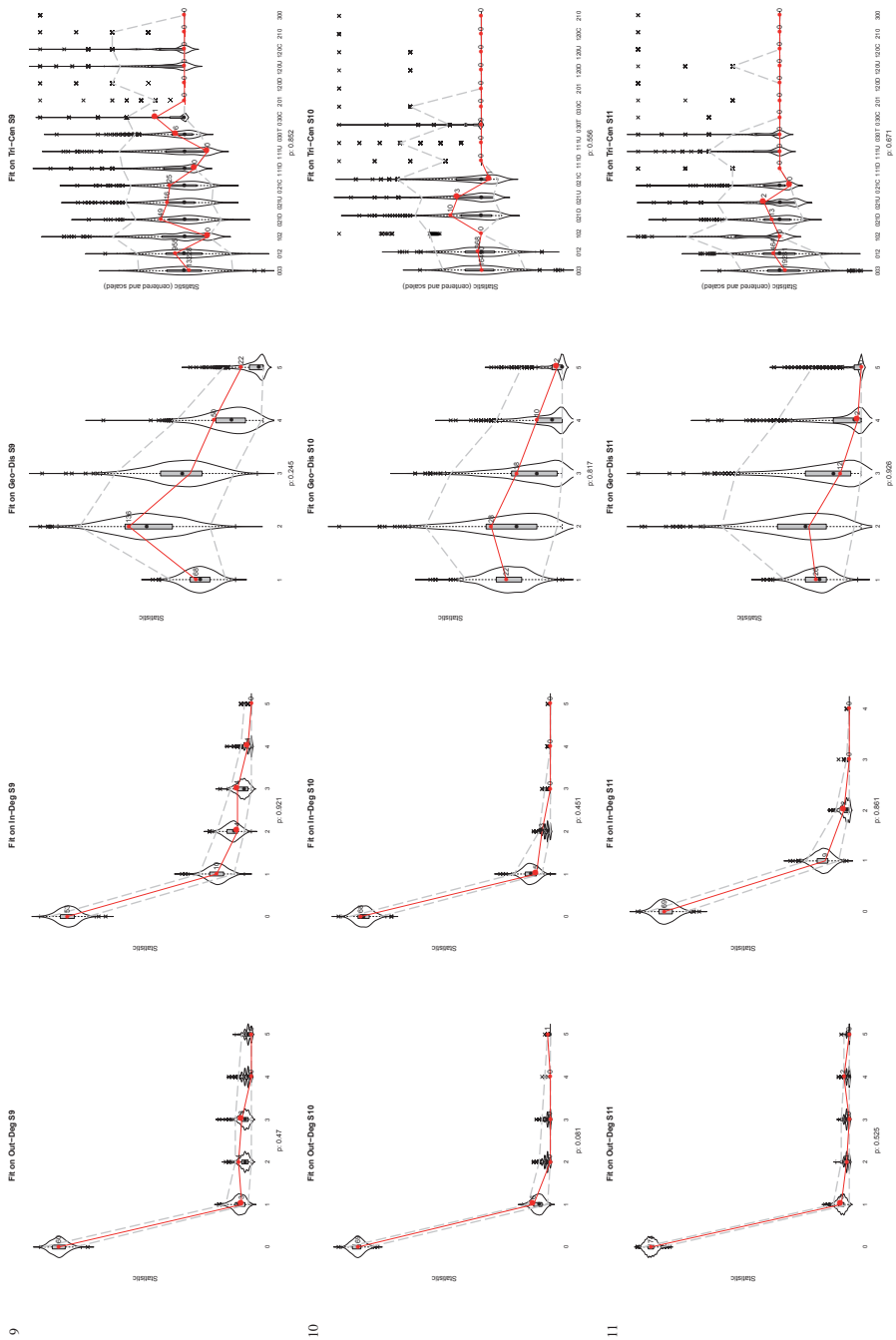
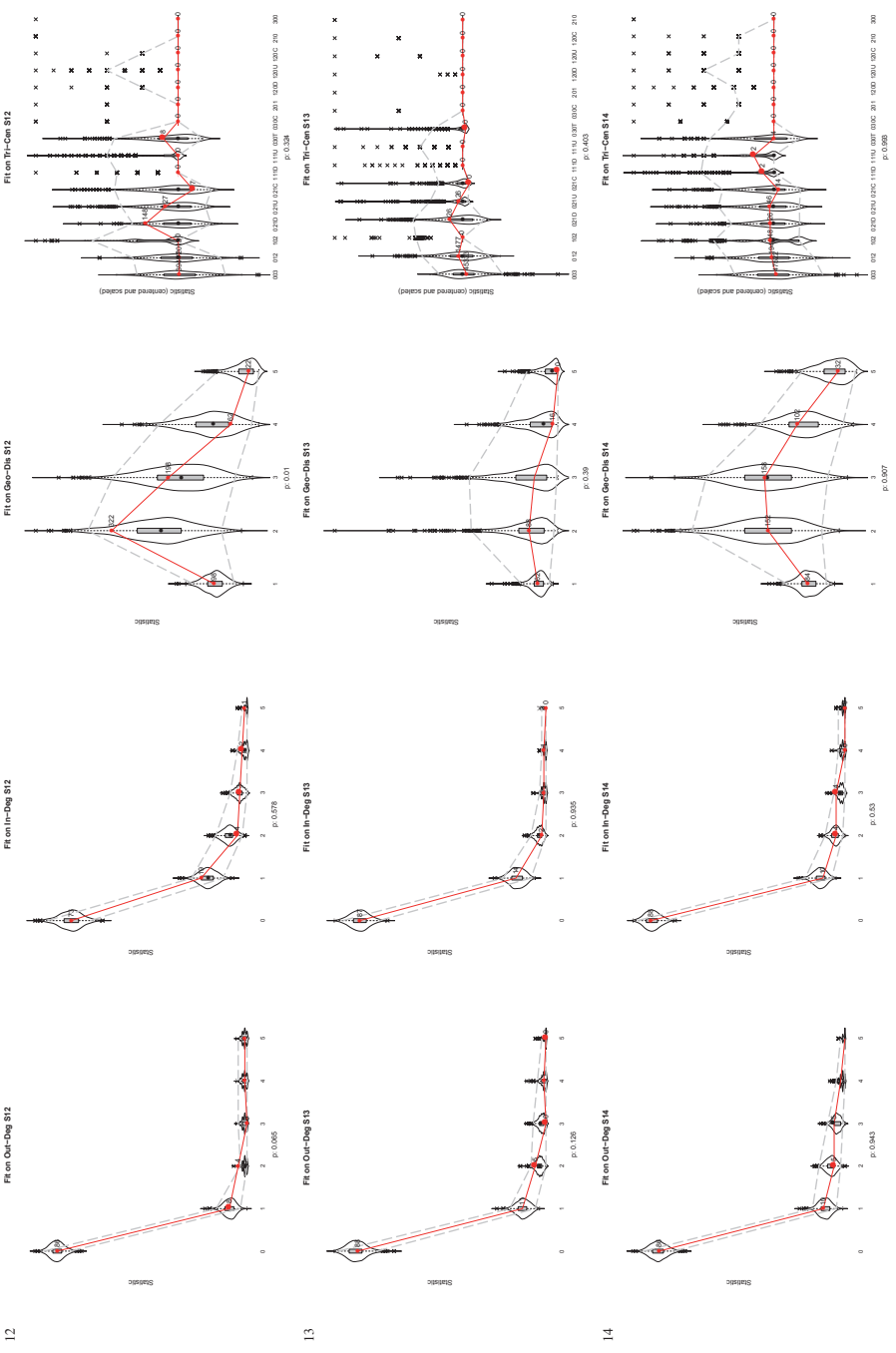


S3.1 Continued.



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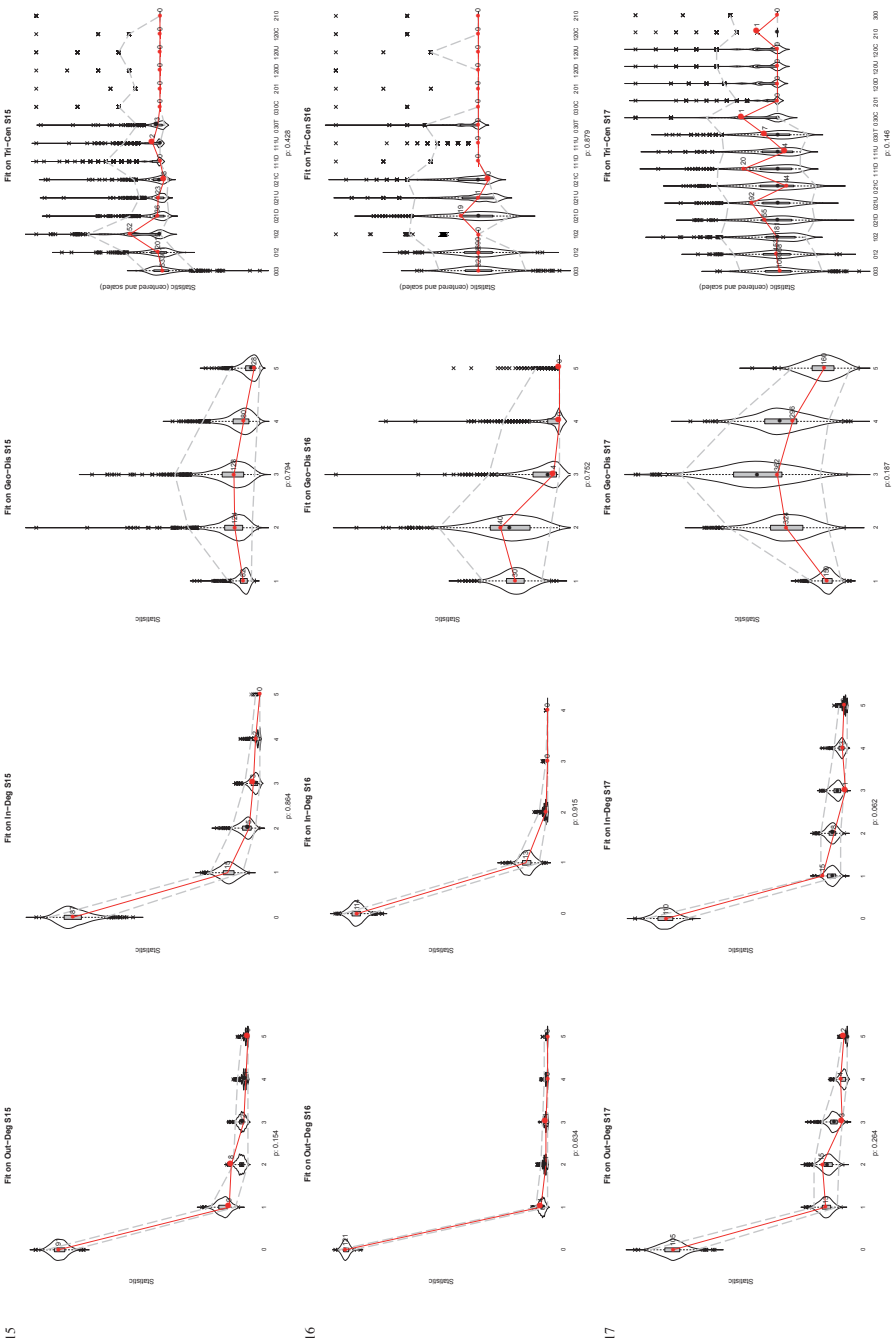

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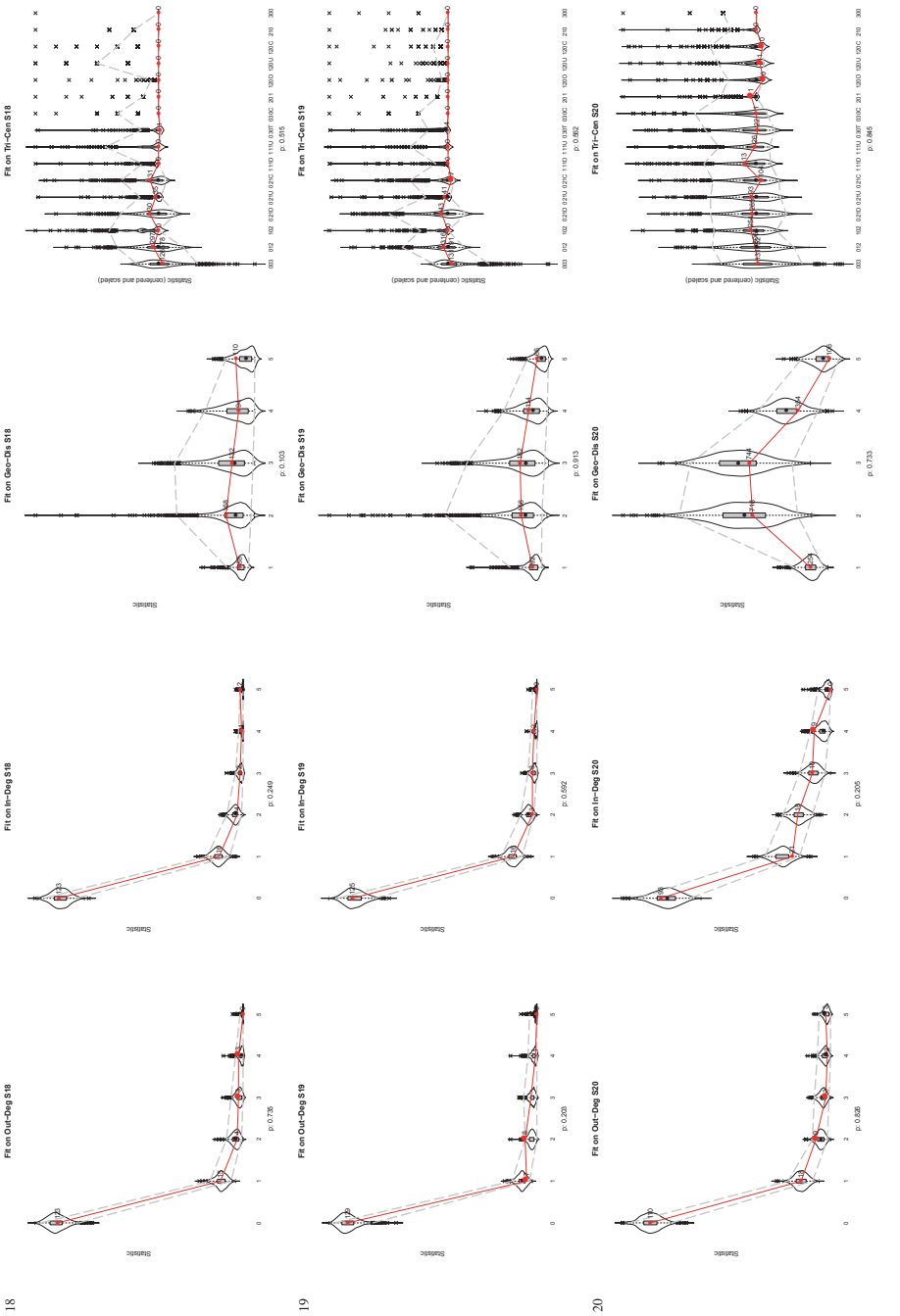

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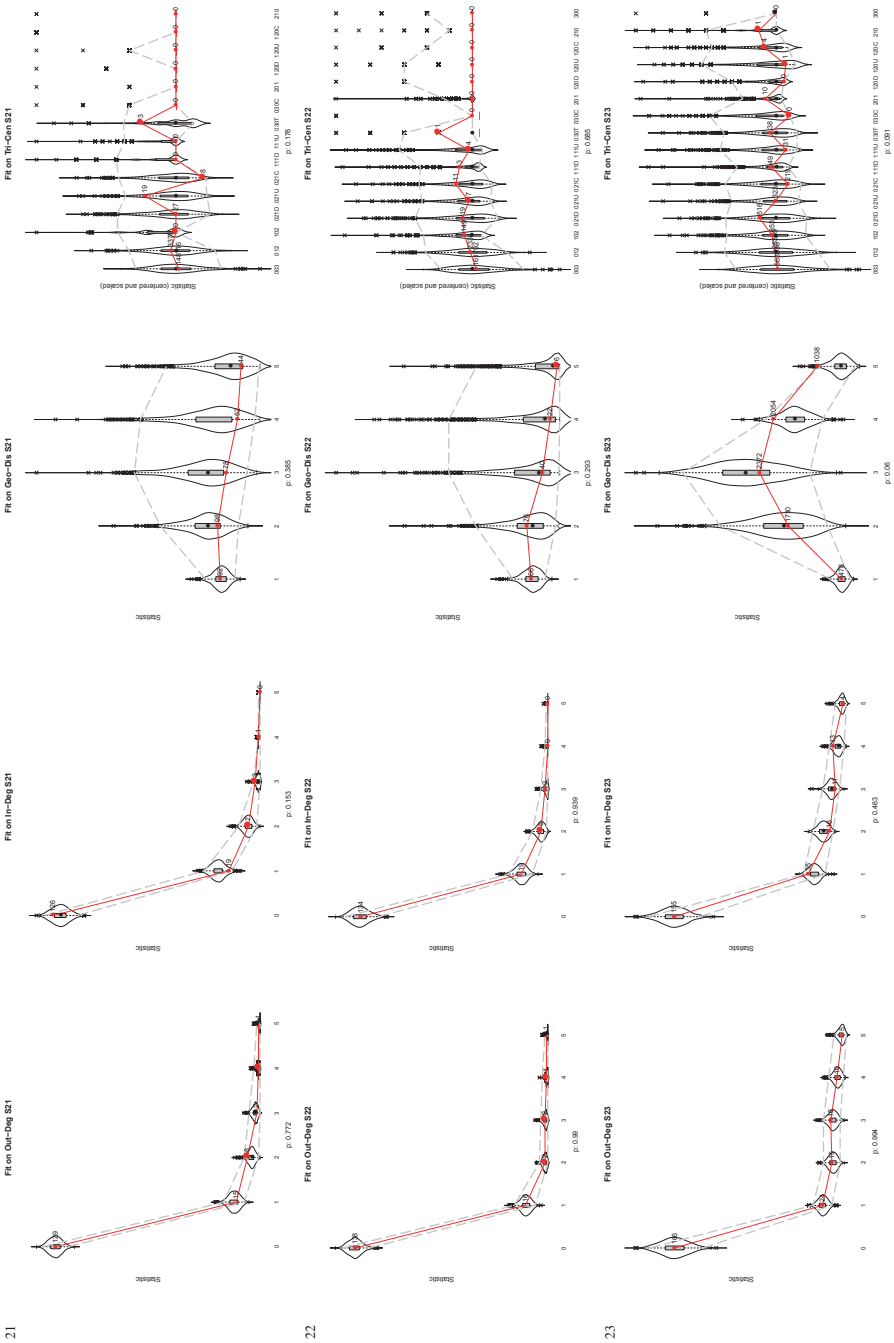

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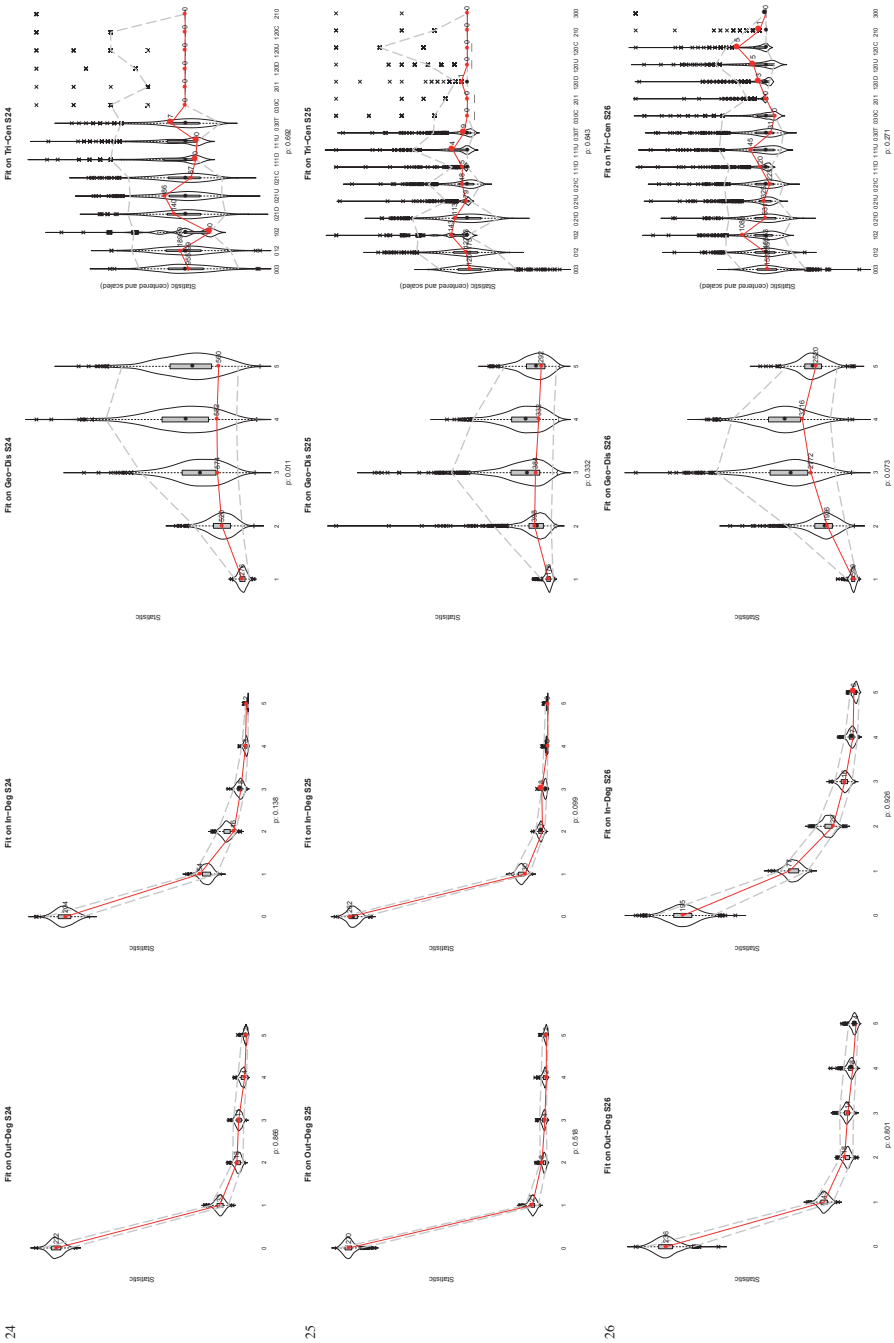

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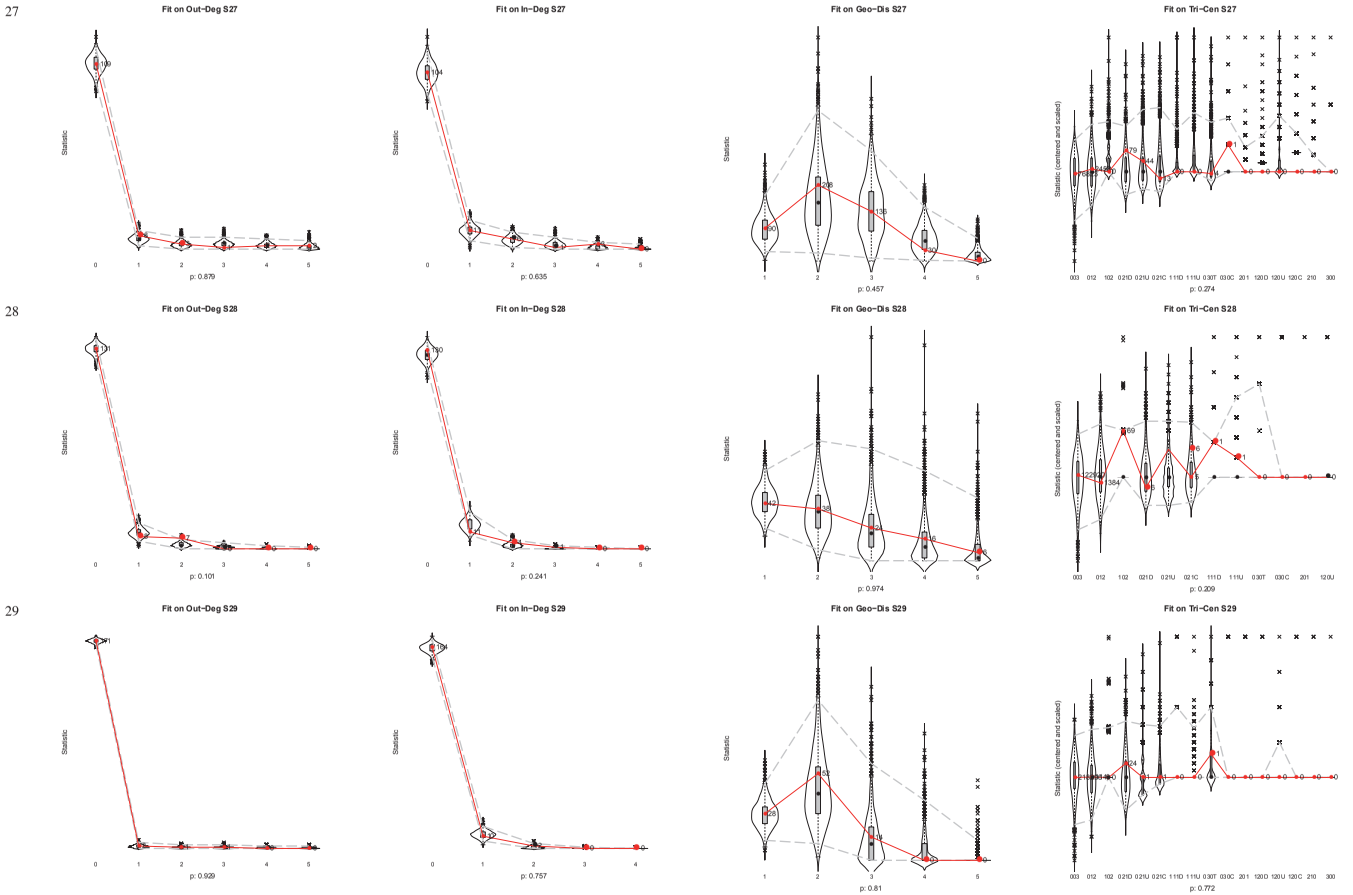
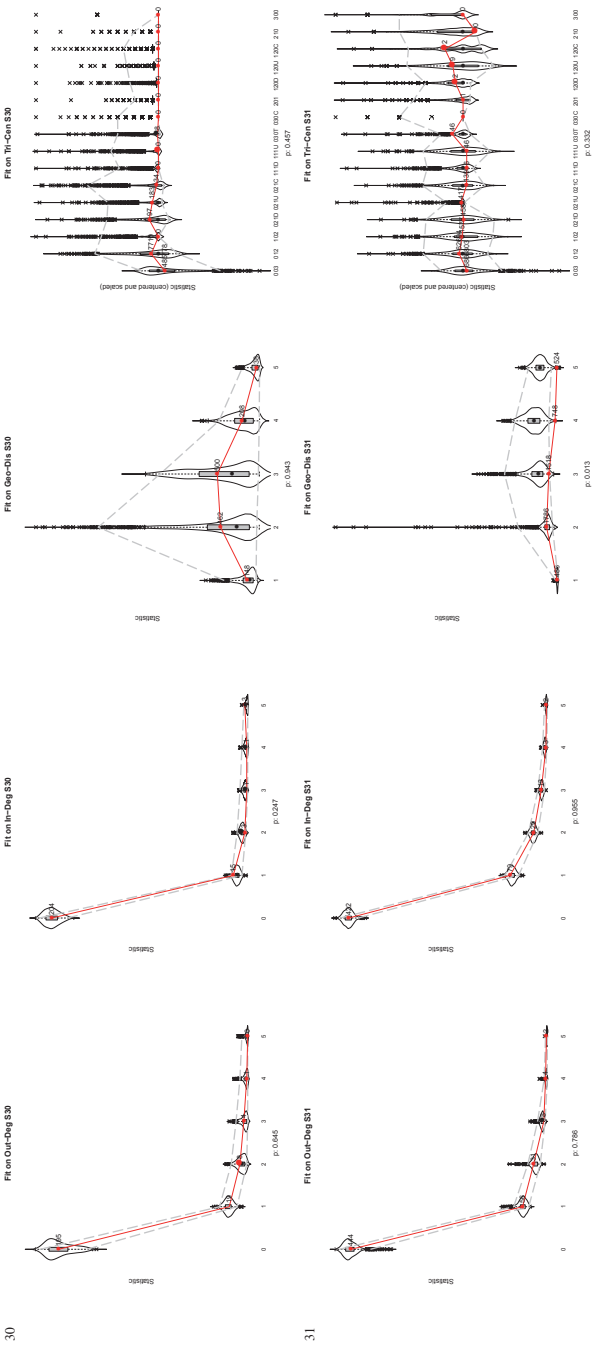


S3.1 Continued.



S3.1 Continued.

S3.2 Overview of the descriptive statistics summarized in Table 3.2.

	Stable (schools 1 to 8)								Unstable administrative-grade (schools 9 to 26)							
School	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Total size[a]	91	93	110	118	172	204	206	209	36	38	40	51	53	54	56	64
Av. grade T1[b]	3.4	3.4	3.4	3.6	3.3	3.3	3.6	3.5	3.4	3.3	3.3	2.6	4.1	2.9	3.4	3.1
Age (in years) T1	9.7	9.7	9.6	9.8	9.6	9.6	9.8	9.6	9.7	9.4	9.3	8.9	10.3	8.9	9.4	9.4
Boys	45%	48%	47%	49%	51%	50%	59%	47%	56%	58%	45%	53%	43%	48%	54%	50%
Av. degree[c] T1	1.6	1.5	0.9	2.2	1.4	2.0	1.5	1.3	1.7	0.8	1.6	1.8	1.5	1.8	1.2	1.1
Av. degree[c] T3	0.6	1.3	0.6	1.1	2.1	1.3	1.0	1.0	1.5	1.6	0.6	0.9	0.5	1.9	0.6	0.3
Av. degree[c] T5	0.8	0.7	0.7	1.5	2.1	1.4	0.5	0.8	1.0	0.5	0.3	0.6	0.4	1.2	1.4	0.6
Respondents																
joining school T3	2	1	5	9	5	1	9	8	1	5	3	1	1	0	1	4
joining school T5	2	0	1	2	0	4	9	12	0	6	0	1	0	1	1	1
joining class T3	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0
joining class T5	1	0	2	0	0	1	2	3	0	0	0	0	0	0	0	0
leaving school T3	6	3	4	3	4	13	1	12	4	9	8	0	2	8	0	3
leaving school T5	23	14	22	39	59	51	60	55	12	5	8	6	18	7	17	17
staying school T3	81	89	100	104	163	186	187	177	31	18	29	49	50	45	54	56
staying school T5	60	76	83	74	109	136	136	130	20	18	24	44	33	38	38	43
Stability rate[d] T1-T3	80%	74%	85%	72%	90%	78%	86%	77%	46%	33%	56%	45%	92%	46%	51%	83%
Stability rate[d] T3-T5	86%	95%	90%	90%	85%	89%	82%	76%	42%	25%	66%	91%	60%	49%	45%	48%
Overall stability T1-T5	83%	84%	88%	81%	88%	84%	84%	76%	44%	29%	61%	68%	76%	48%	48%	66%

S3.2 Continued.

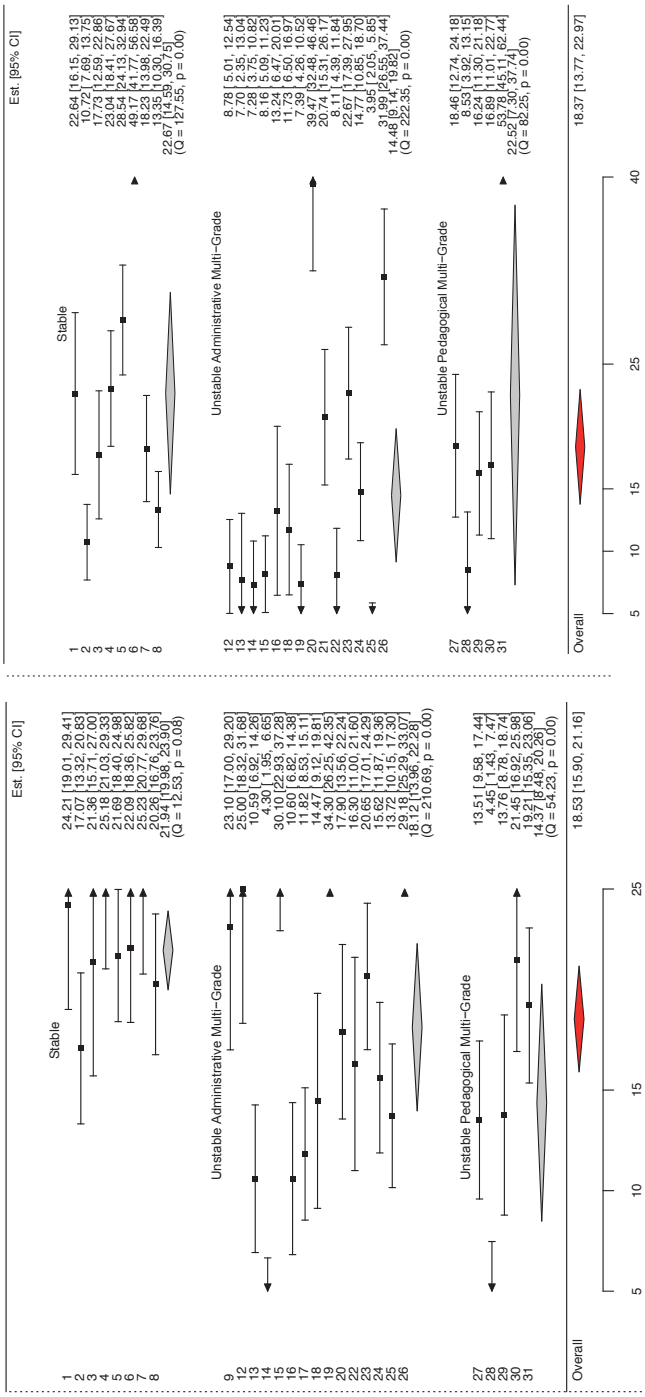
	Unstable administrative-grade (schools 9 to 26)										Unstable pedagogical multigrade (schools 27 to 31)				
School	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Total size[a]	71	74	75	76	78	80	122	144	155	169	63	73	88	115	276
Av. grade T1[b]	3.4	3.6	3.5	2.6	3.3	3.6	3.2	3.5	3.3	3.6	2.3	3.5	3.0	3.6	3.3
Age (in years) T1	9.7	9.2	9.7	8.7	9.5	9.8	9.5	9.7	9.4	9.8	8.7	9.5	9.2	10.1	9.2
Boys	63%	61%	39%	42%	53%	46%	51%	56%	51%	47%	46%	37%	55%	48%	48%
Av. degree[c] T1	1.5	1.3	2.5	2.3	1.2	0.9	3.5	0.8	1.1	1.7	2.0	0.6	0.9	2.1	1.2
Av. degree[c] T3	1.5	1.2	1.5	1.6	1.1	0.4	2.0	0.5	0.7	1.2	1.6	0.6	0.9	2.0	1.5
Av. degree[c] T5	0.8	1.2	1.3	3.0	1.3	0.3	1.7	1.0	0.2	1.3	1.3	0.8	1.6	1.2	1.2
Respondents															
joining school T3	1	2	4	0	4	0	2	5	4	5	2	5	7	1	6
joining school T5	3	1	6	0	3	2	3	4	7	3	7	8	14	8	9
joining class T3	1	0	2	0	0	0	0	5	2	2	0	0	0	7	9
joining class T5	0	0	0	0	1	0	0	2	2	0	0	0	0	9	2
leaving school T3	8	14	11	2	15	2	0	7	11	2	9	16	19	24	40
leaving school T5	16	15	13	18	16	21	39	35	34	41	9	15	7	26	54
staying school T3	59	57	54	74	56	76	117	128	133	159	45	44	48	82	221
staying school T5	44	44	45	56	44	55	80	98	103	123	38	34	48	57	173
Stability rate[d] T1-T3	47%	53%	48%	68%	54%	61%	93%	54%	80%	68%	46%	40%	37%	59%	40%
Stability rate[d] T3-T5	43%	44%	39%	62%	66%	69%	45%	40%	68%	62%	51%	31%	58%	51%	28%
Overall stability T1-T5	45%	48%	44%	65%	60%	65%	69%	47%	74%	65%	48%	36%	48%	55%	34%

Notes. [a]Total size contains the total number of students in a particular school across all three time points (T1, T3, and T5). This involves all missing cases, joining, leaving, and staying. [b]Grade ranged from 2 to 5 at T1 (save exceptions due to combination groups). [c]Average degree is the average number of bully nominations sent per student in a particular school. This is calculated among the students who were part of the school at the day of the data collection and who filled out the questionnaire. [d]The stability rate shows the average score per school across all students who were part of the school at the day of the data collection (a visual plot is shown in Figure 3.2 in Chapter 3).

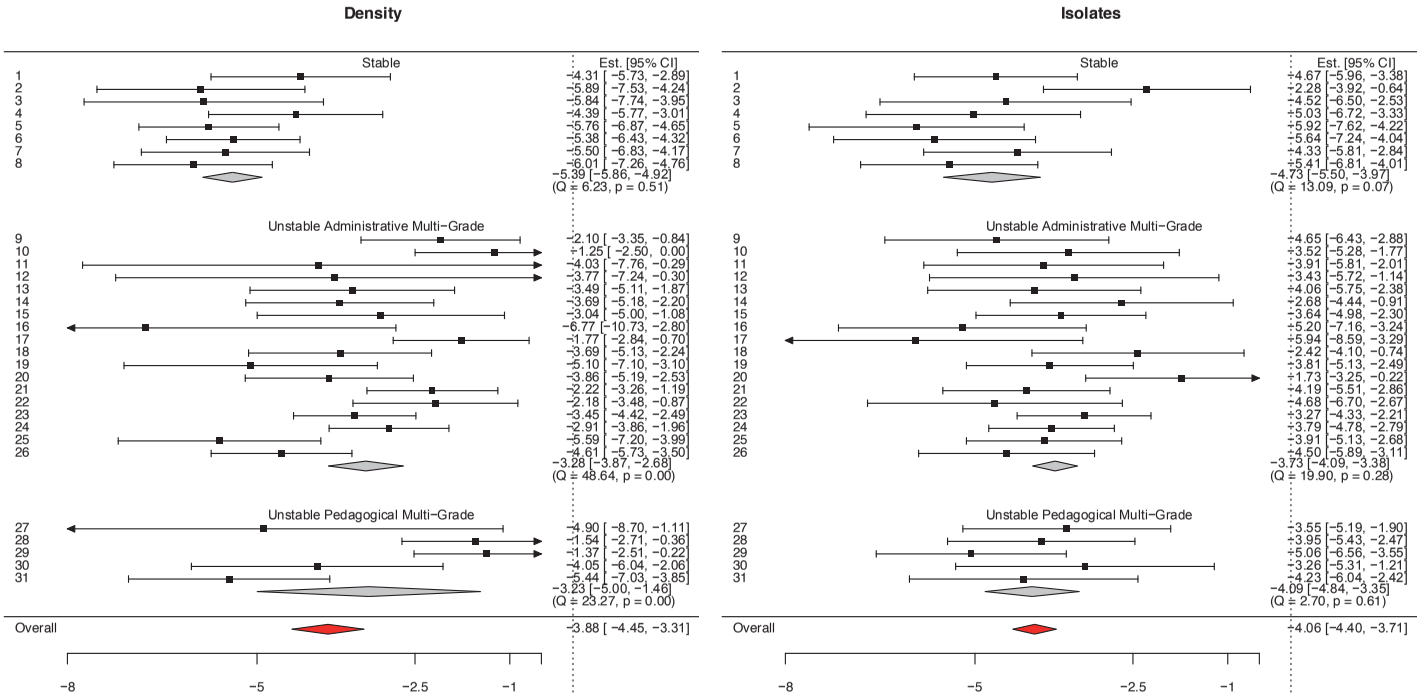
S3.3 Meta-analysis of school-wide victimization networks (31 schools, 3,254 students) – results for all schools and the three different school types *without* controlling for effects of school size[a]

	All schools		Intercept (stable)		Unstable administrative multigrade		Unstable pedagogical multigrade	
	Est.	SE	Est.	SE	Est.	SE	Est.	SE
Rate effects								
Network rate w1-w3	18.53***	1.34†	22.10***	2.38†	-4.14	2.96	-7.73*	3.83
Network rate w3-w5	18.37***	2.35†	22.68***	4.23†	-8.14	5.30	-0.42	6.87
Network effects								
Density	-3.88***	.29†	-5.38***	.43†	2.10***	.52	2.35**	.73
Isolates	-4.06***	.18†	-4.74***	.31	.99**	.37	.65	.51
Sex effects								
Sex (boy) alter	.40***	.08	.40**	.12	-.06	.17	.19	.26
Sex (boy) ego	-.18***	.08	-.16	.12	-.03	.16	-.02	.25
Same sex	.28***	.08	.22+	.13	.18	.17	-.19	.26
Individual effects								
Newcomer ego	.16	.11	-.07	.19	.38	.25	32	.37
Grade effects								
Grade alter	.15**	.06	.22*	.10	-.09	.13	-.10	.17
Grade ego	-.15**	.05	-.21*	.10	.11	.13	.003	.17
Same grade	1.13***	.11†	1.40***	.17	-.30	.22	-.81**	.28
Classroom effects								
Same class now	.03	.11	.38*	.19	-.57*	.24	-.32	.34
Same class before	.02	.09	.005	.14	-.02	.19	.19	.28
Number of schools	31		8		18		5	
Number of students	3,254		1,203		1,436		615	

Notes. $+p < .10$, $*p < .05$, $**p < .01$, $***p < .001$. †Significant differences between schools. In some (smaller) schools, rate parameters were unreasonably high because there were few or no stable ties from one time point to the next. As a possible solution, the rate parameters were fixed at the observed value (see Ripley et al., 2019). [a]The model specification consisted out all the effects reported in Table 3.1 in Chapter 3 (effect of time not reported, which was included to stabilize the estimation process). As can be seen, the results were substantially similar in terms of effect estimates as those reported in Table 3.4 in Chapter 3, but there was an additional effect of school size for the same class now and same class before effects. Apparently, these effects are found more in the larger schools compared to the smaller schools.

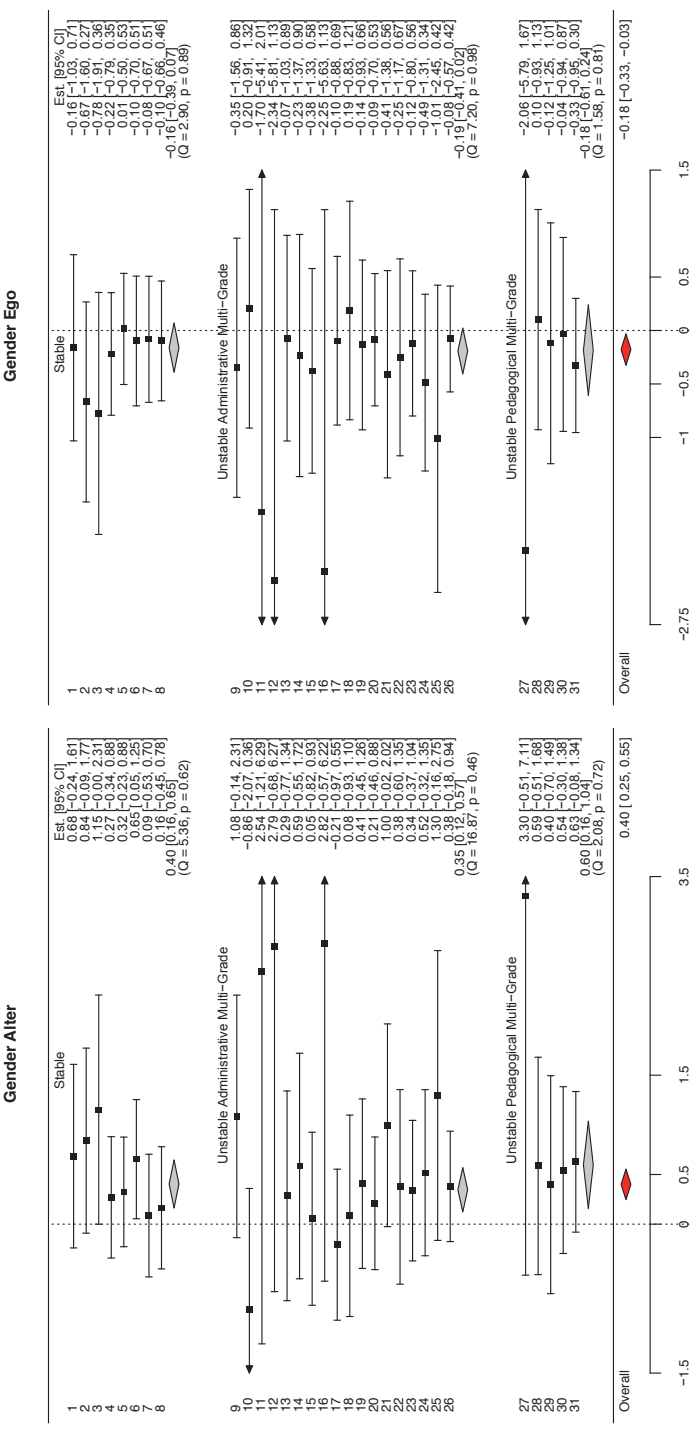


S3.4 Forest plots of results of separate schools summarized across all schools and per school type.

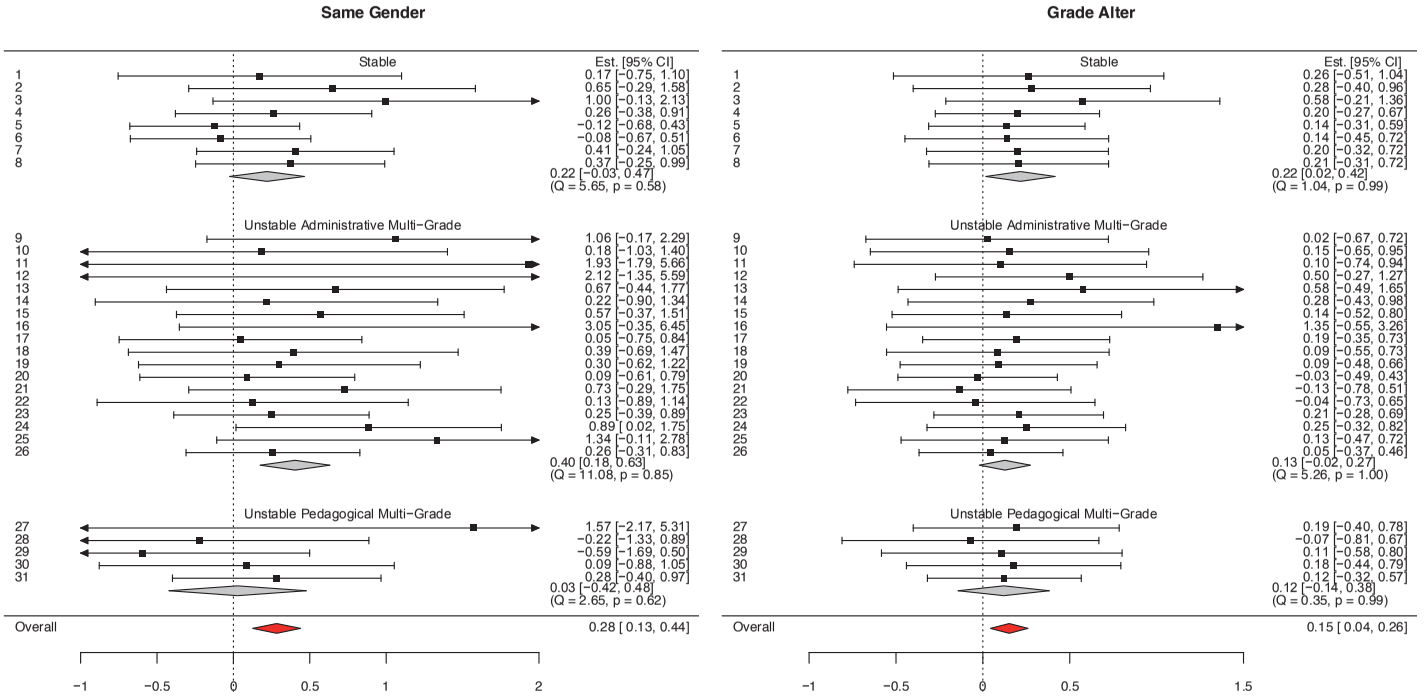


S3.4 Continued.

Supplements

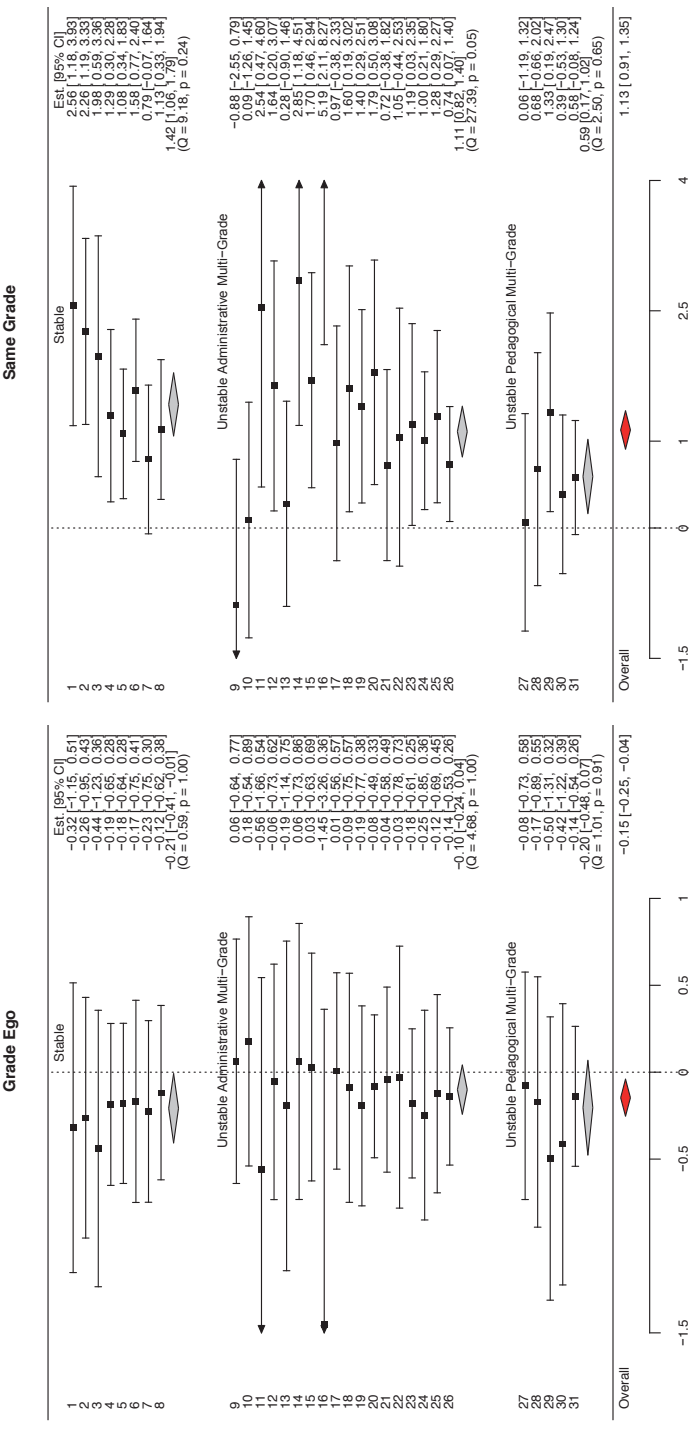


S3.4 Continued.



S3.4 Continued.

Supplements



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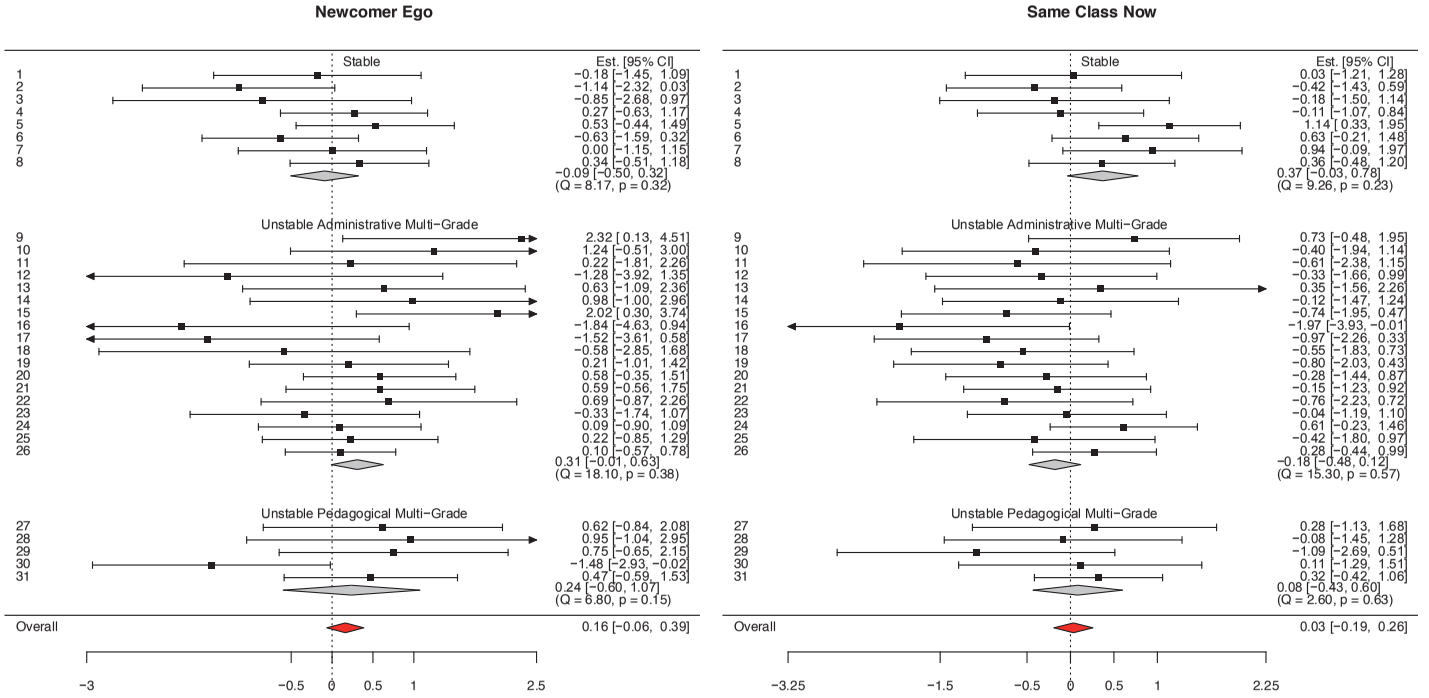
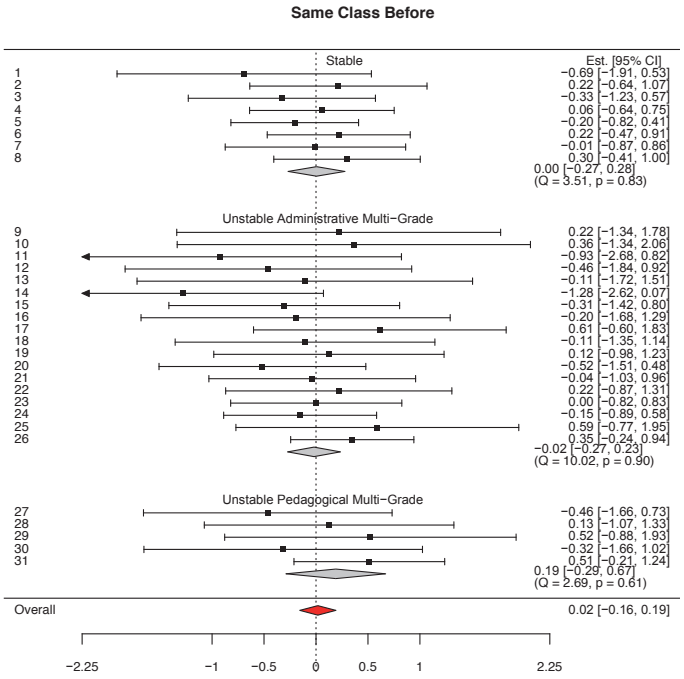


S3.4 Continued.



S3.4 Continued.

S3.5 Meta-analysis of school-wide victimization networks (31 schools, 3,254 students) – results for all schools and separated for the three different school types – using the exact same model specification[a]

	All schools		Stable		Unstable administrative multigrade		Unstable pedagogical multigrade	
	Est.	SE	Est.	SE	Est.	SE	Est.	SE
Rate effects								
Network rate w1-w3	17.75***	1.29[†]	2.54***	.85	17.55***	2.04[†]	13.91***	3.22[†]
Network rate w3-w5	16.29***	1.54[†]	19.50***	2.61[†]	13.32***	2.04[†]	19.48**	3.64[†]
Network effects								
Density	-2.61***	.13[†]	-3.14***	.17	-2.38***	.16[†]	-2.17***	.34[†]
Isolates	-3.97***	.11	-4.05***	.17	-3.88***	.16	-4.04***	.29
Sex effects								
Sex (boy) alter	.61***	.08	.64***	.12	.51**	.11	.84***	.22
Sex (boy) ego	-.15*	.07	-.10	.11	-.17	.11	-.19	.21
Same sex	.27***	.08	.20	.12	.39***	.11	.02	.22
Individual effects								
Newcomer ego	.19+	.11	.03	.19	.35*	.16	.07	.33
Grade effects								
Grade alter	.19***	.06	.21*	.10	.17*	.08	.21	.13
Grade ego	-.15**	.05	-.22*	.10	-.10	.07	-.21	.13
Same grade	1.07***	.11[†]	1.35***	.18	1.07***	.14	.51*	.20
Classroom effects								
Same class now	.04	.11	.35+	.19	-.16	.15	.10	.25
Same class before	.06	.09	.08	.14	-.01	.13	.20	.25
Number of schools	31		8		18		5	
Number of students	3254		1203		1436		615	

Notes. $+p < .10$, $*p < .05$, $**p < .01$, $***p < .001$. [†]Significant differences between schools. In some (smaller) schools, rate parameters were unreasonably high because there were few or no stable ties from one time point to the next. As a possible solution, the rate parameters were fixed at the observed value (see Ripley et al., 2019). [a]The model specification consisted out all the effects reported in this table (effect of time not reported, which was included to stabilize the estimation process). Results were substantially the same as those reported in Table S3.3 in the Supplements (except for the newcomer ego effect, which was less positive in pedagogical multigrade schools due to one school (31) turning from positive to negative).

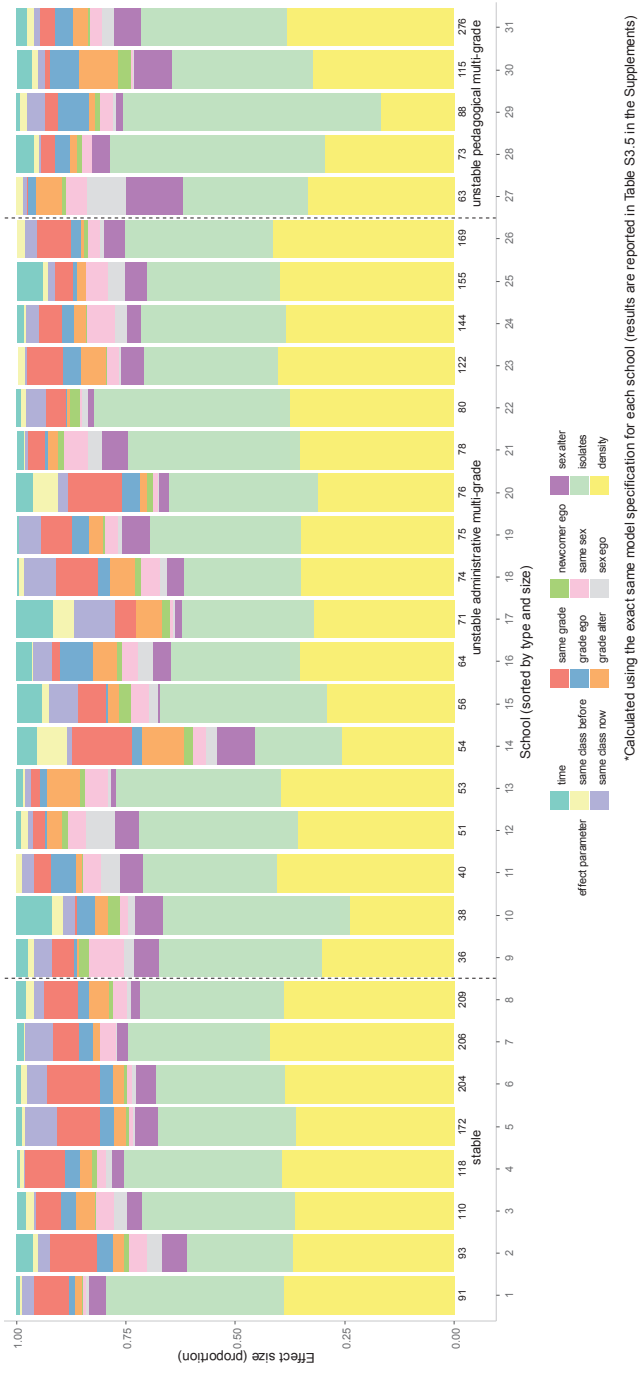


Figure S3.6 A Relative importance of effects contributing to peer victimization*

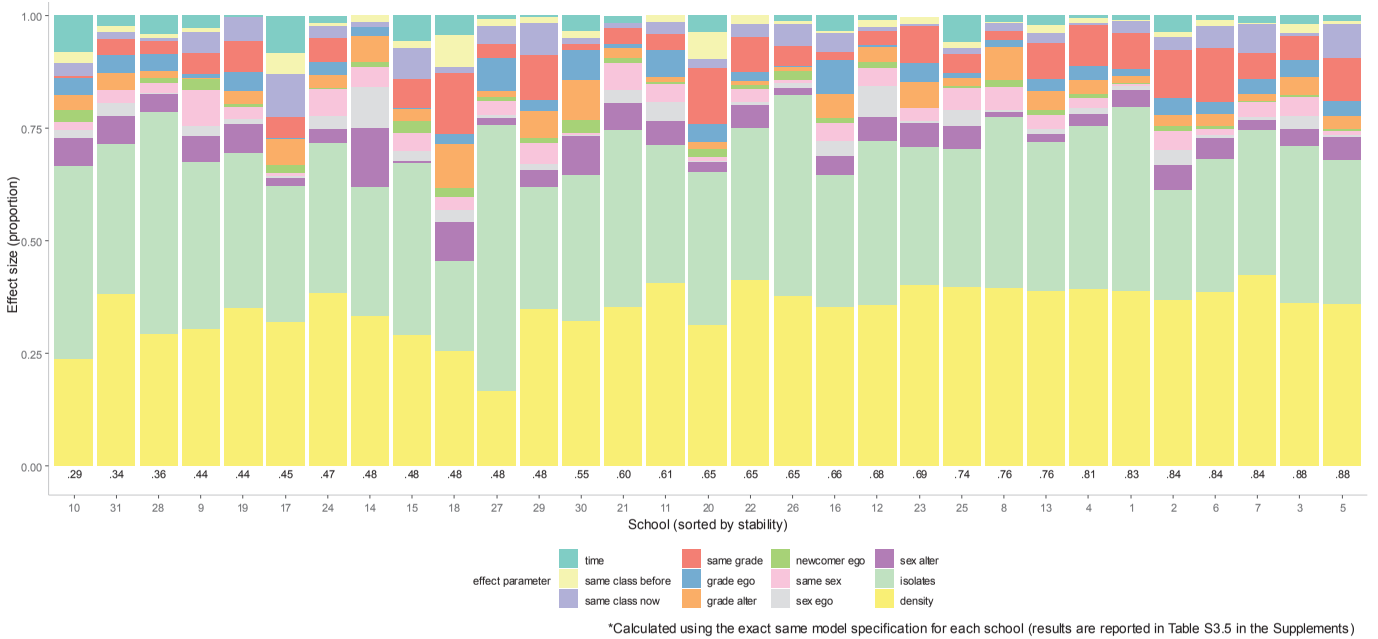


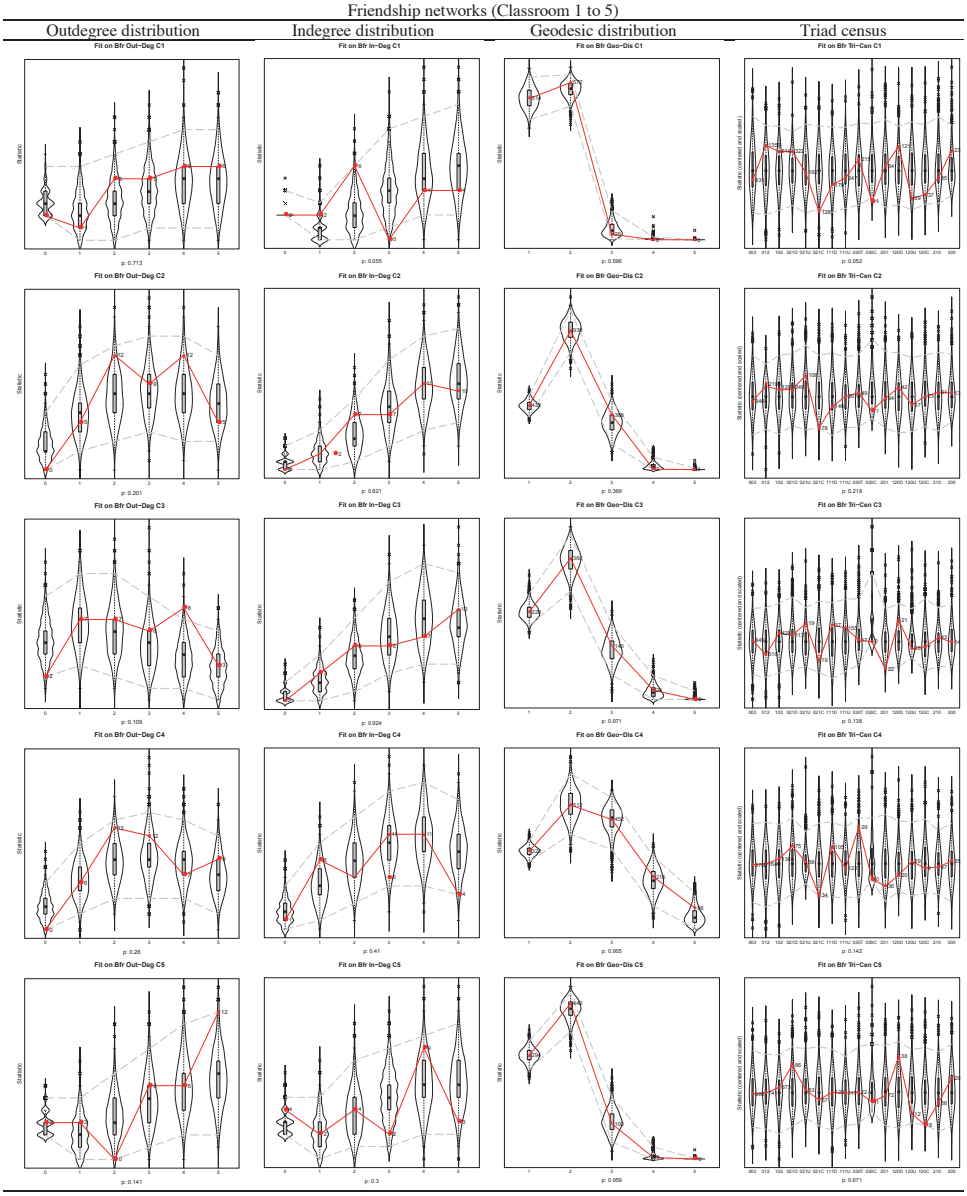
Figure S3.6 B Relative importance of effects contributing to peer victimization*

Supplements Chapter 4

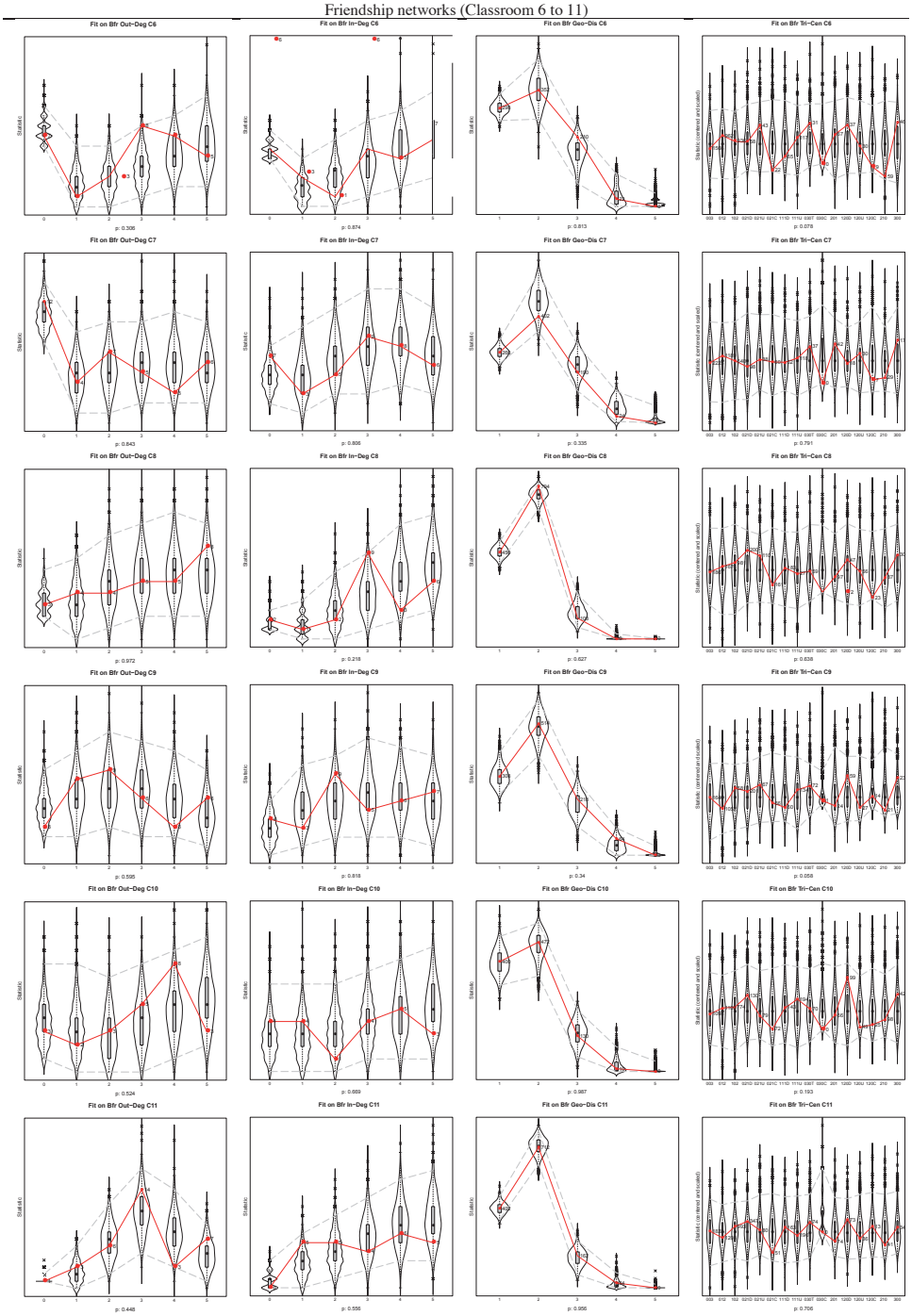
List of supplements:

S4.1 Visualization of Goodness of Fit statistics for models summarized in Table 4.6

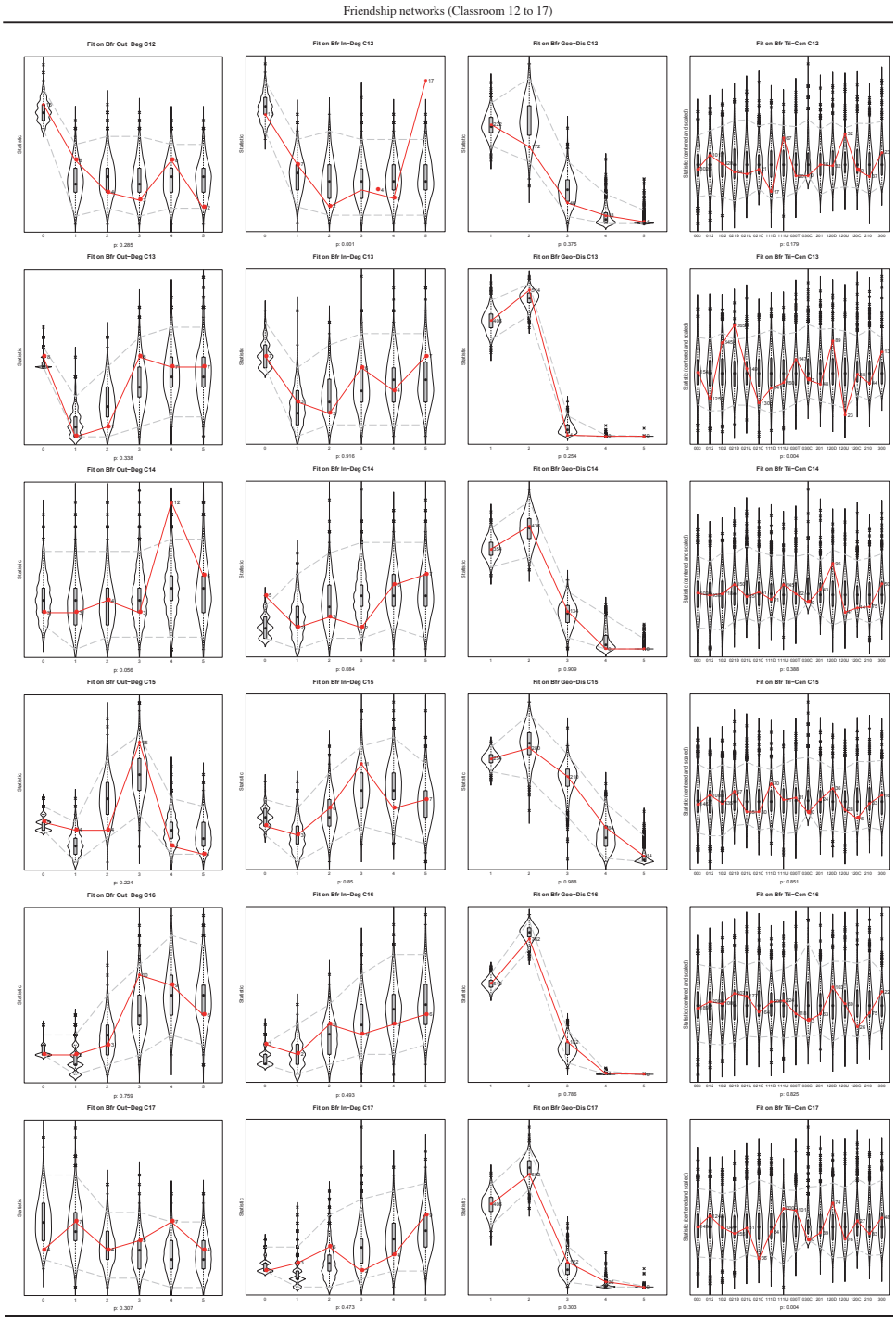
S4.2 Distribution of parameter estimates and standard errors for models summarized in Table 4.6



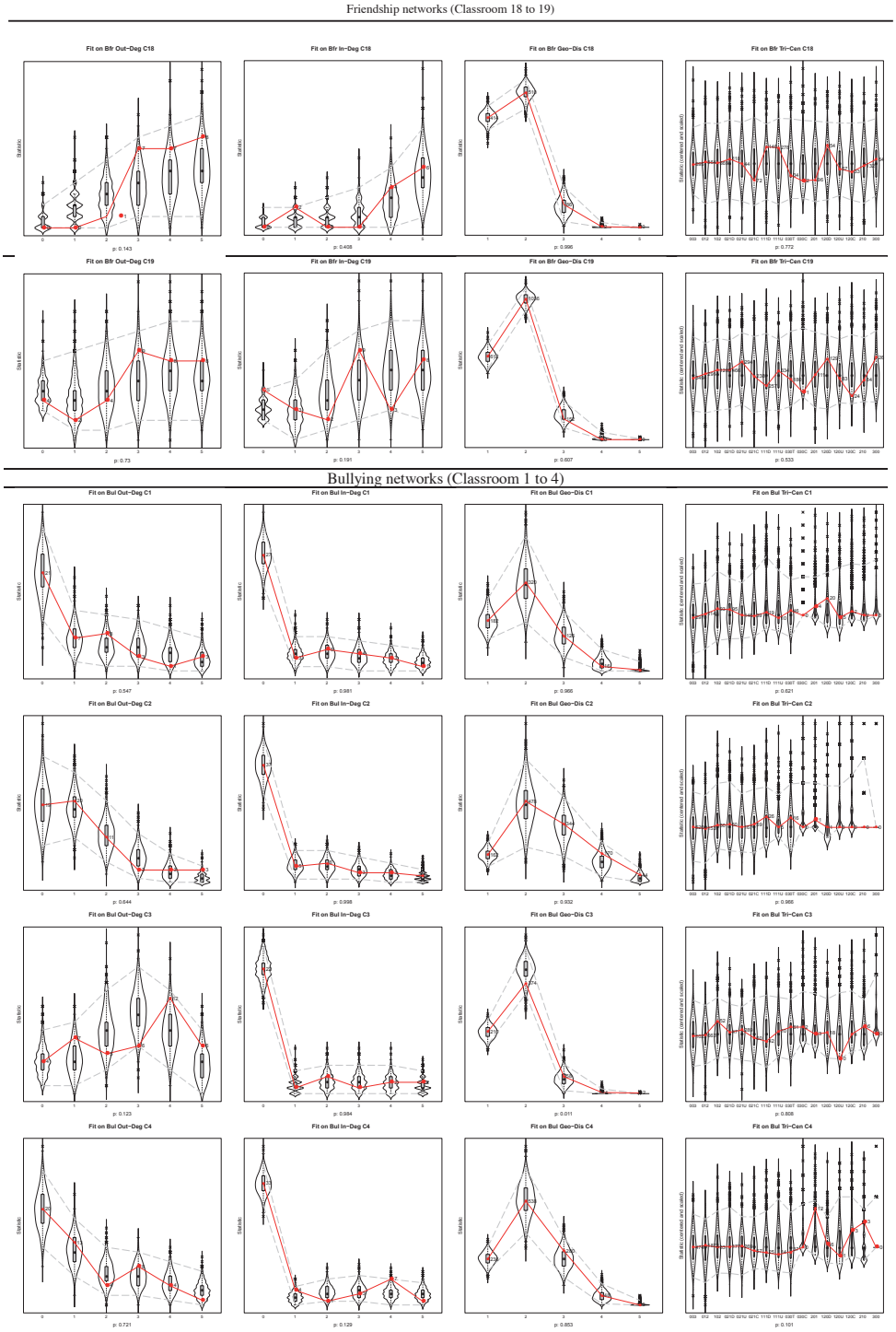
S4.1 Visualization of Goodness of Fit statistics of SIENA multivariate network models summarized in Table 4.6.



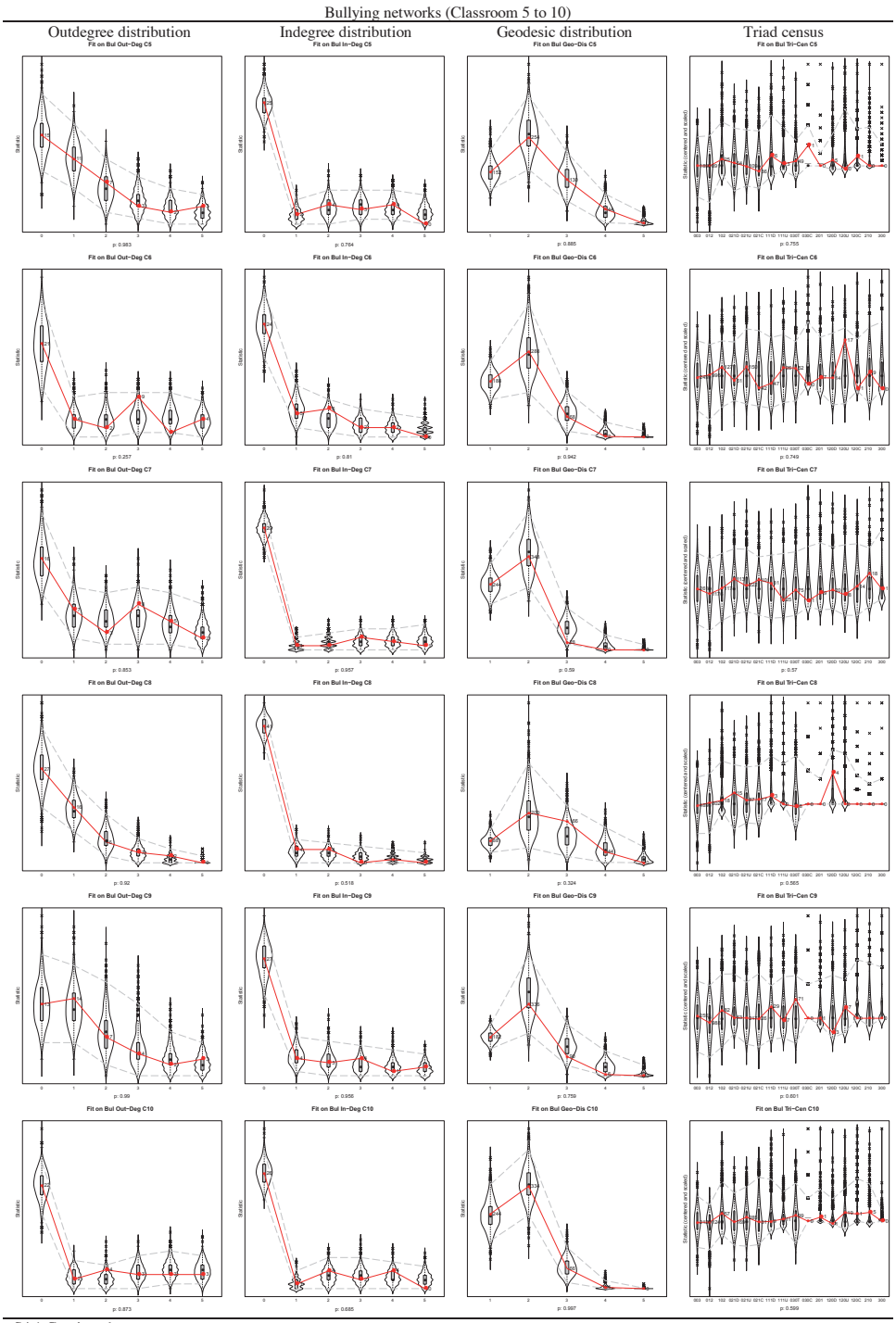
S4.1 Continued.



S4.1 Continued.

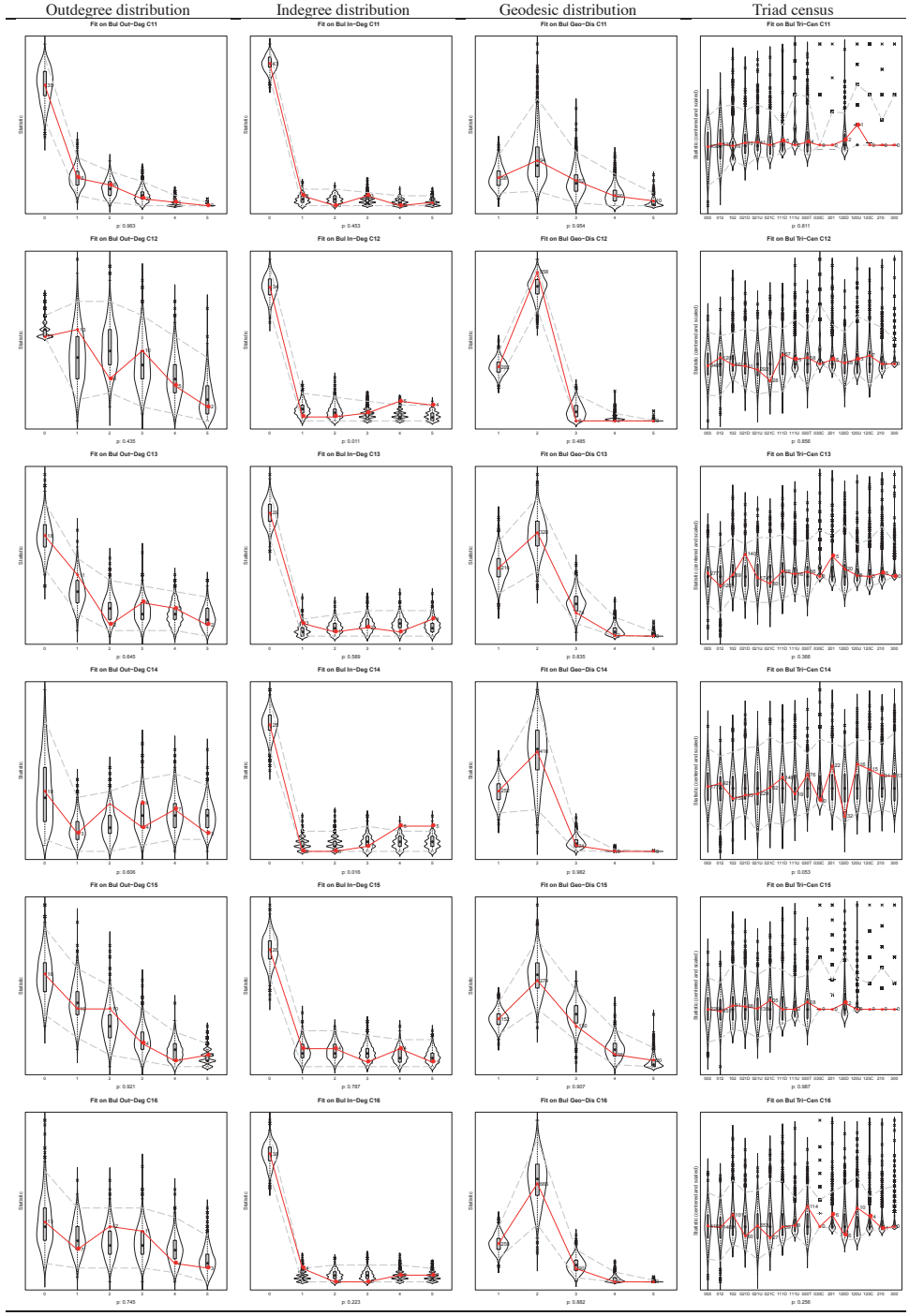


S4.1 Continued.

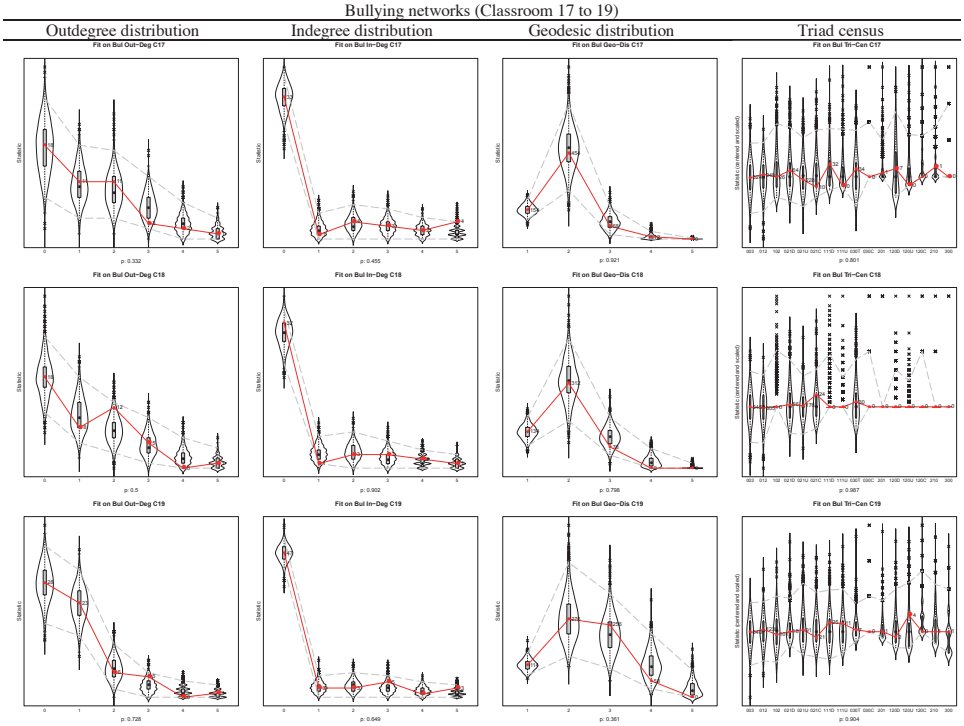


S4.1 Continued.

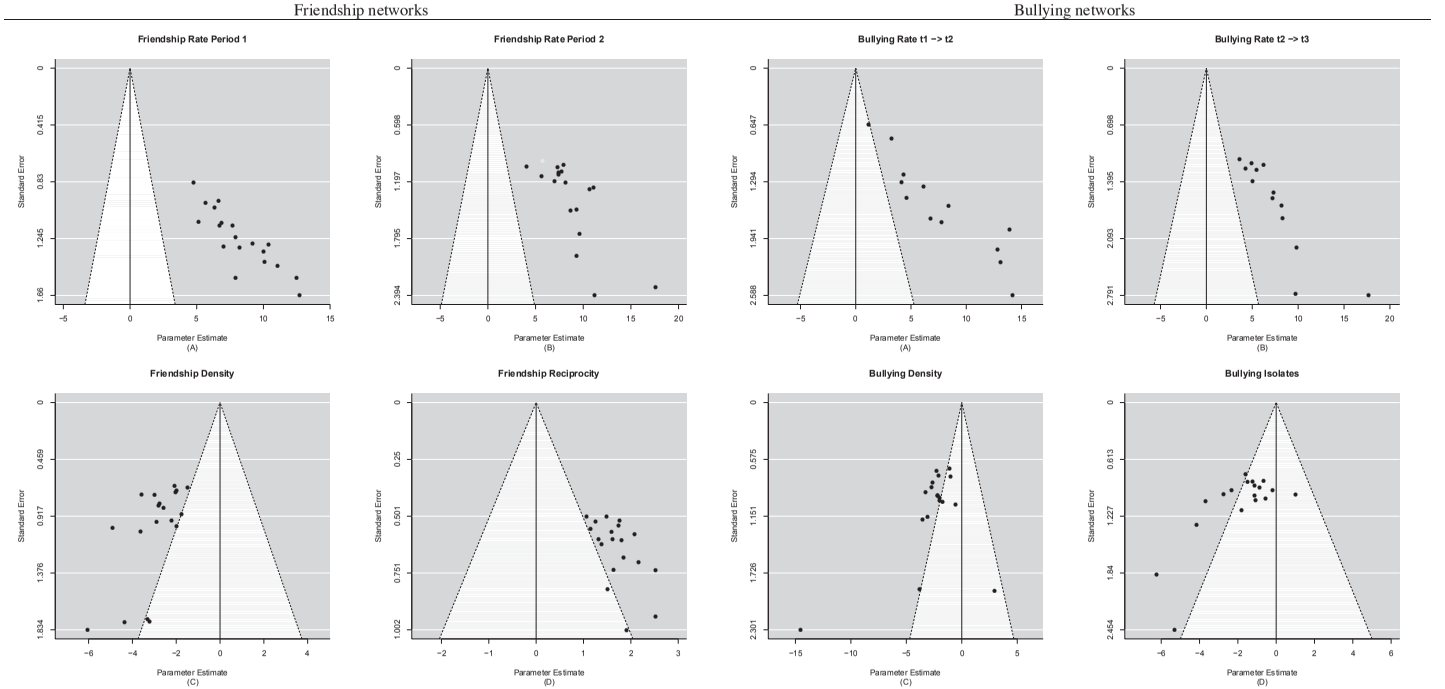
Bullying networks (Classroom 11 to 16)



S4.1 Continued.

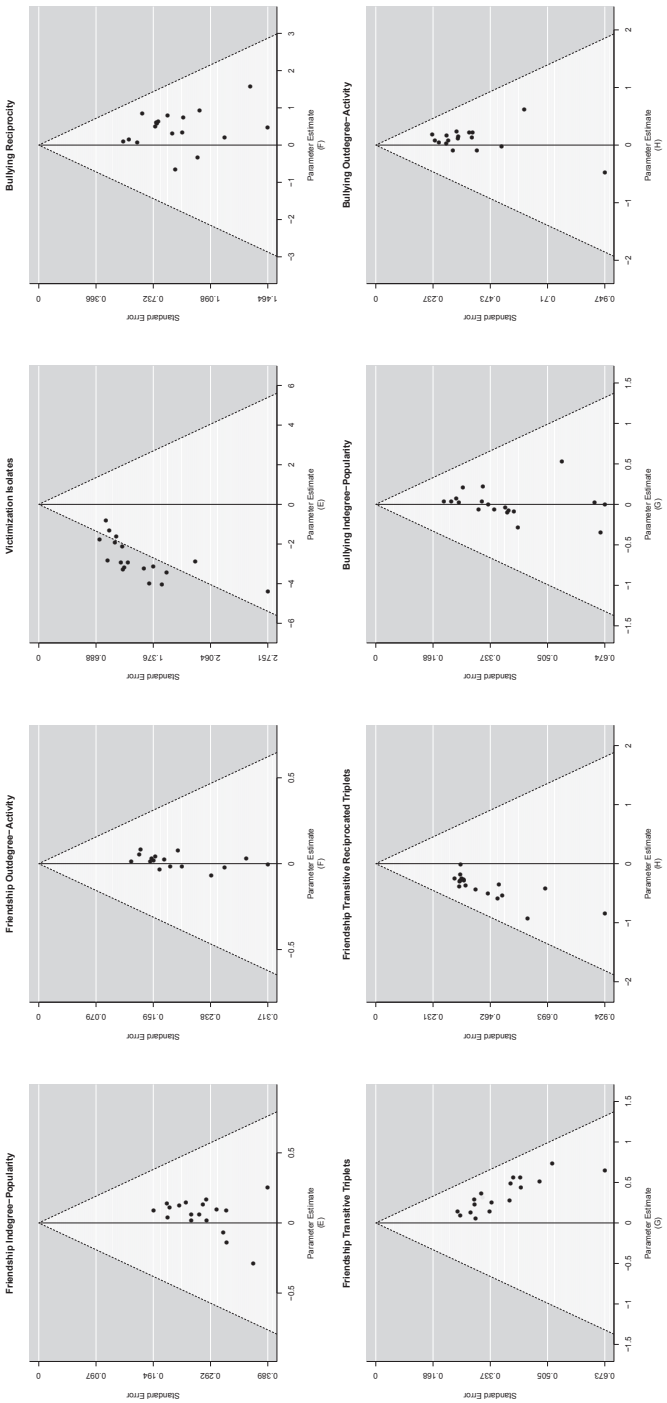


S4.1 Continued.

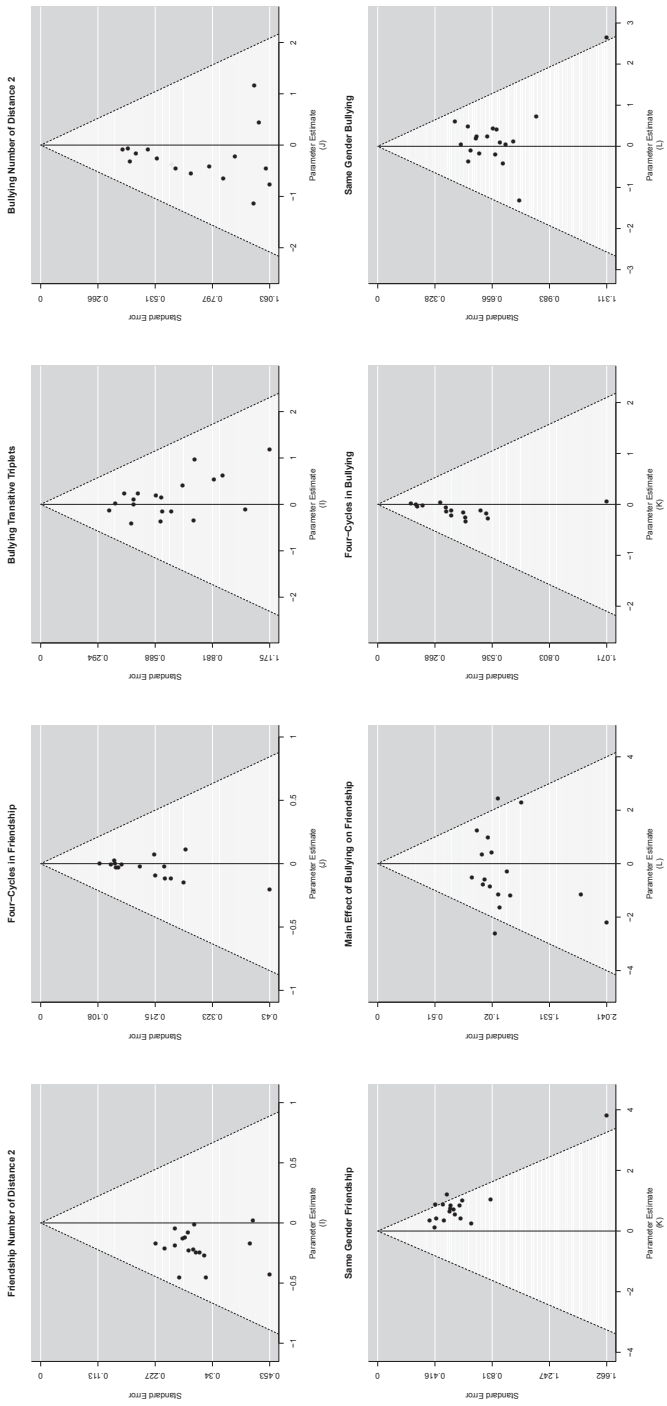


S4.2 Distribution of parameter estimates and standard deviations for SIENA multivariate network models summarized in Table 4.6.

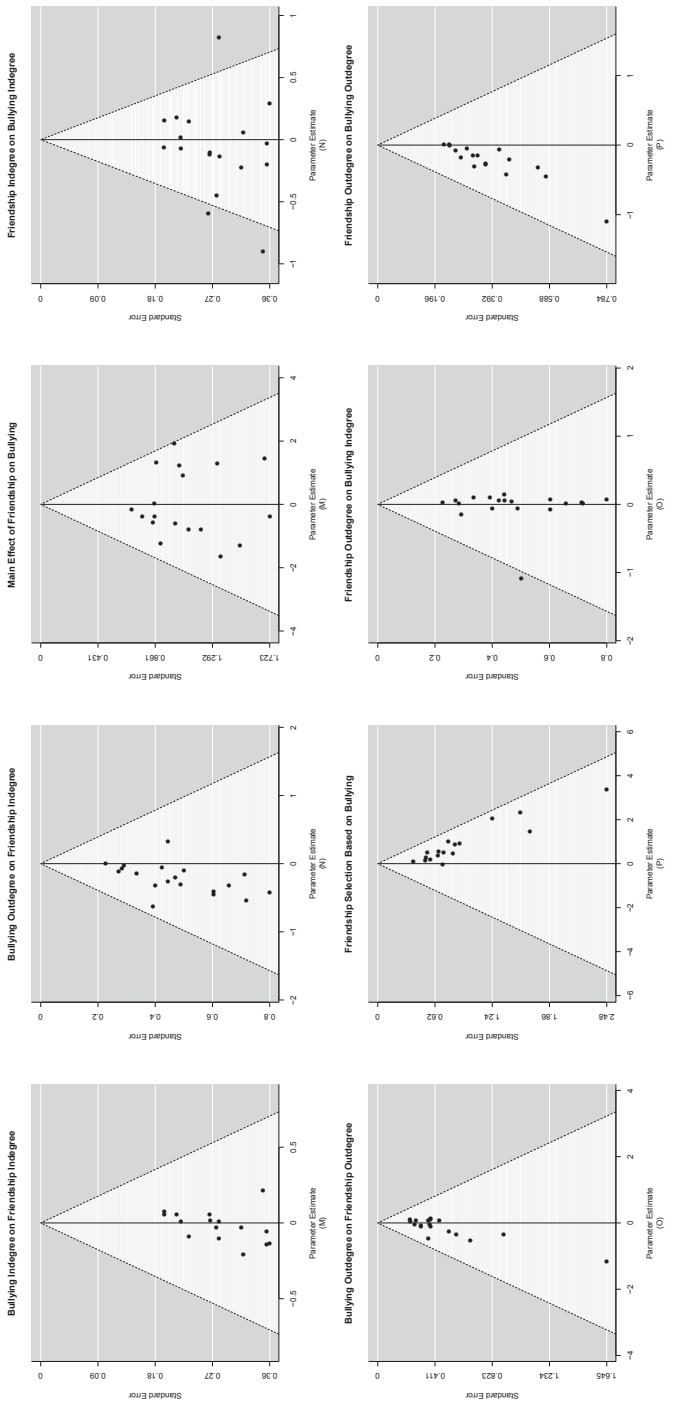
Supplements



S4.2 Continued.



S4.2 Continued.



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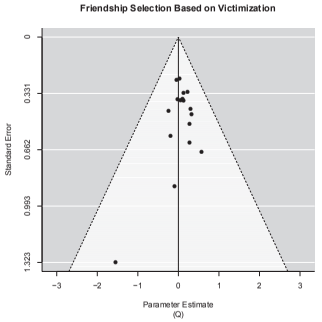
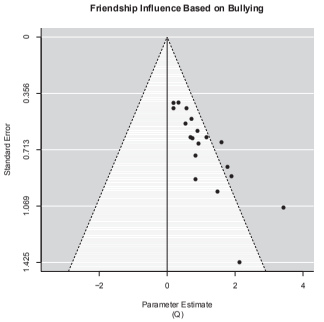
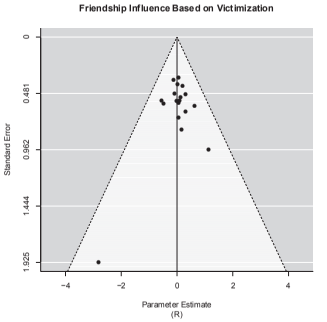






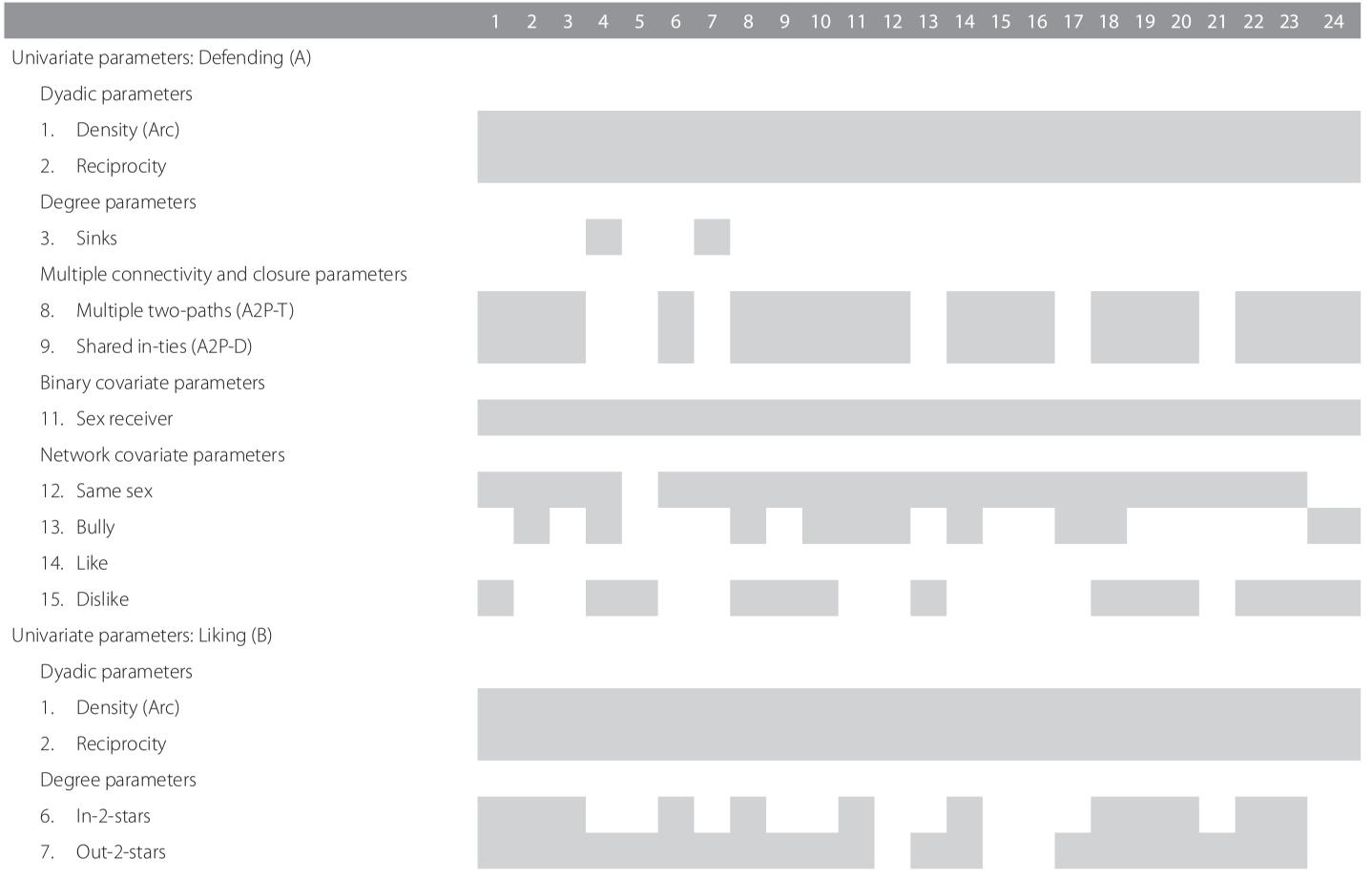
S4.2 Continued.

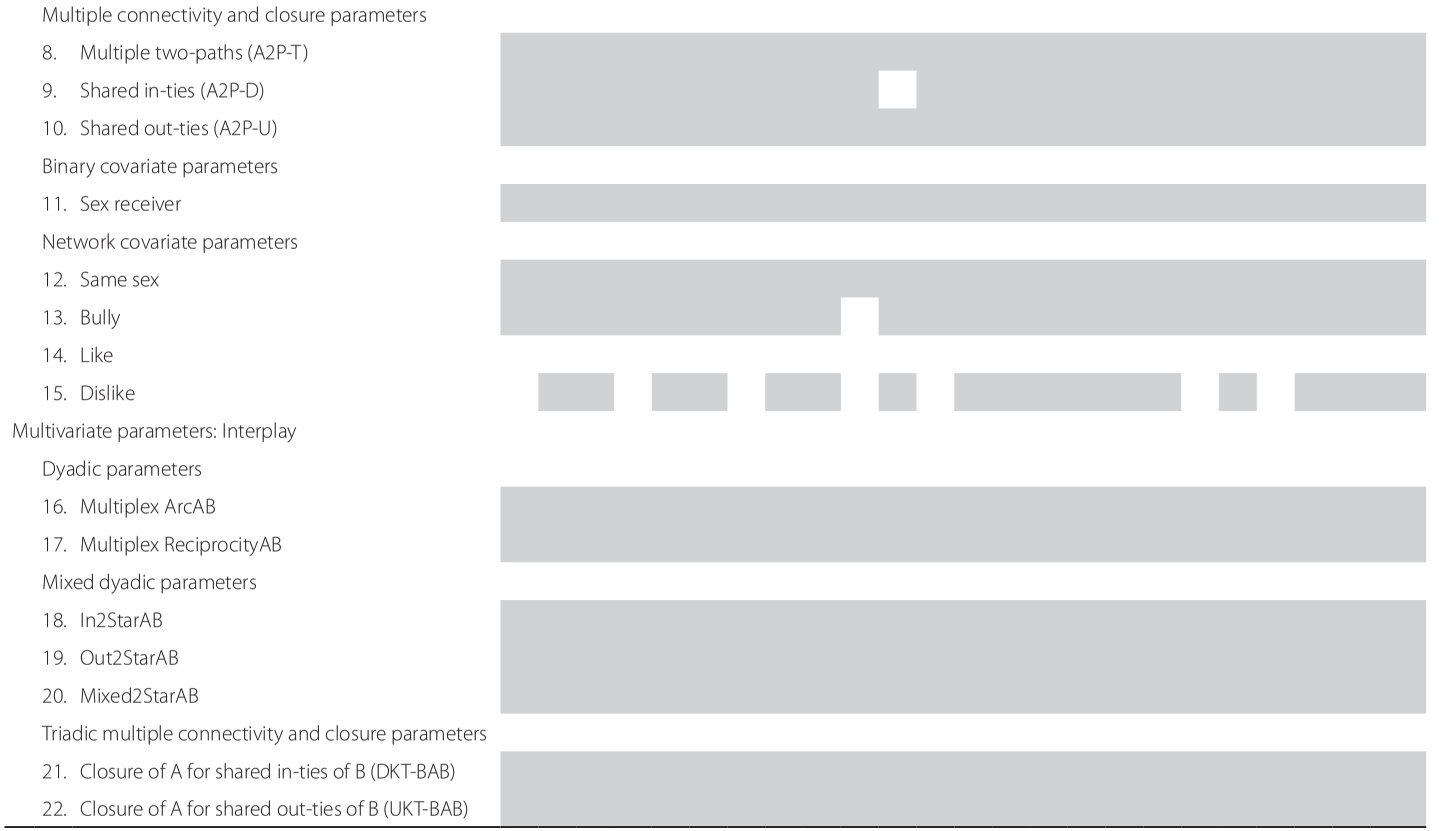
Supplements Chapter 5

List of supplements:

S5.1 Overview of the model effects for each classroom network model
S5.2 Overview of goodness of fit statistics for each classroom network model
S5.3 Overview of individual and classroom information for each classroom

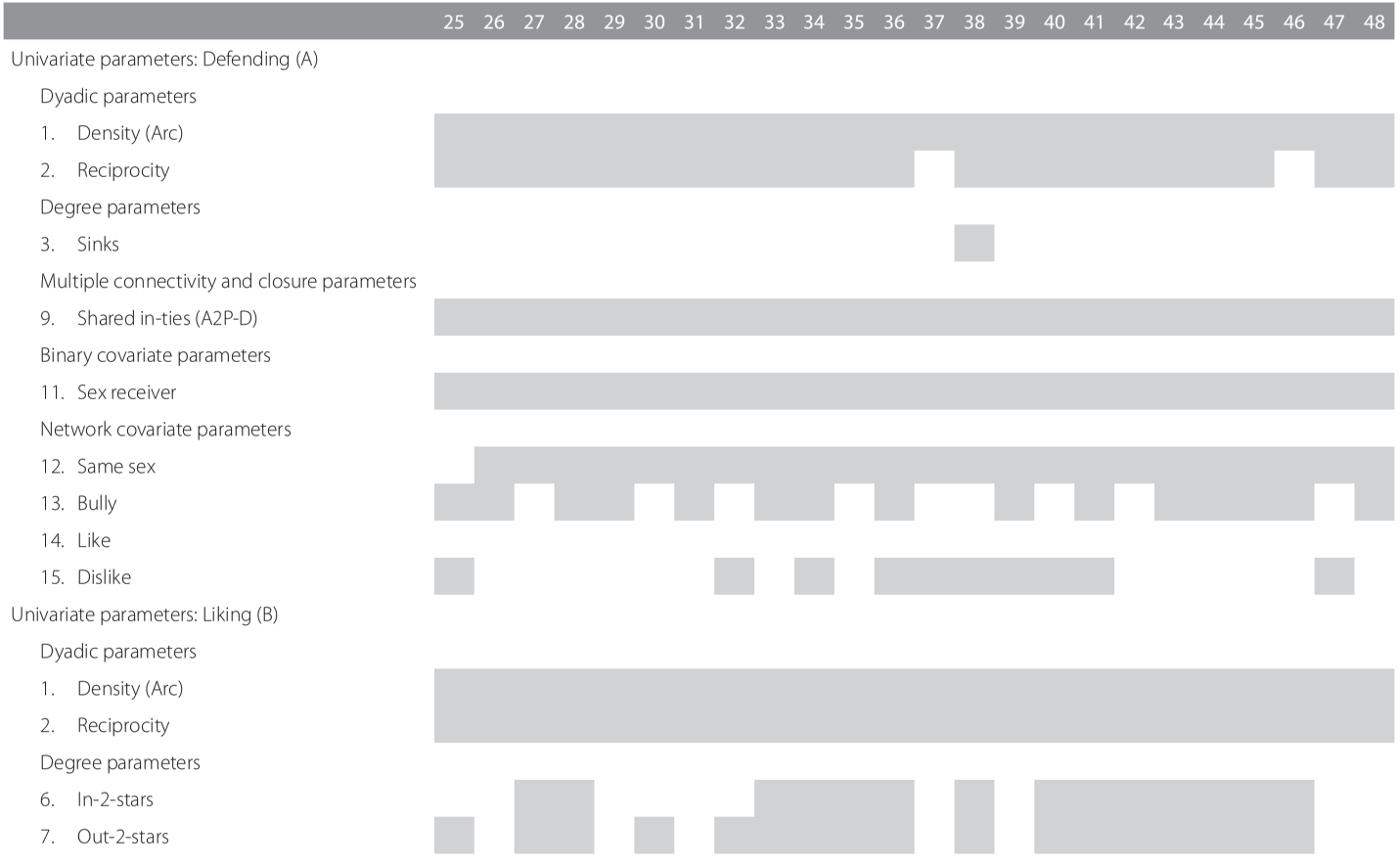
S5.1.1 Overview of the model effects for each classroom network model of defending (A) and liking (B). Classroom 1 thru 24.

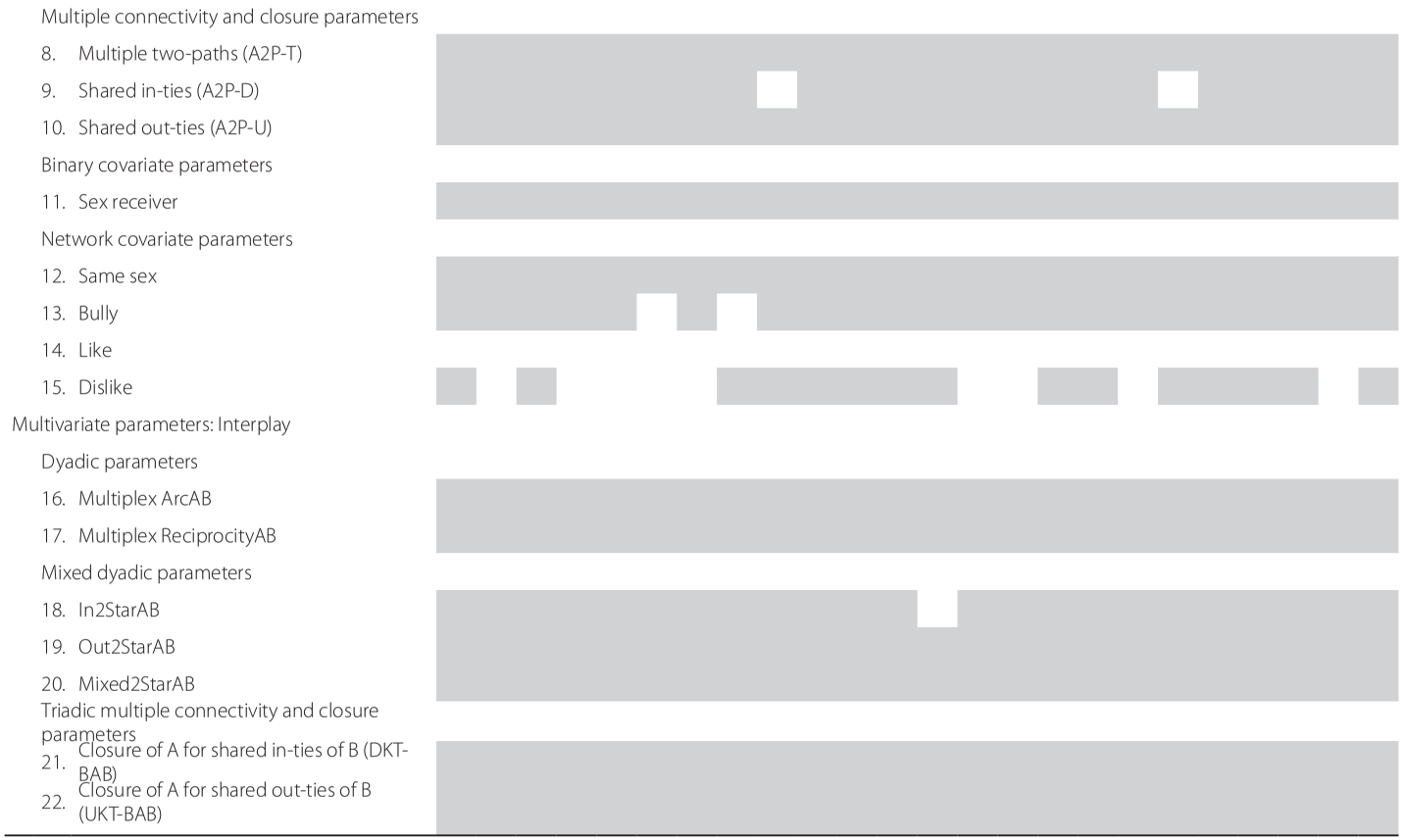




Supplements

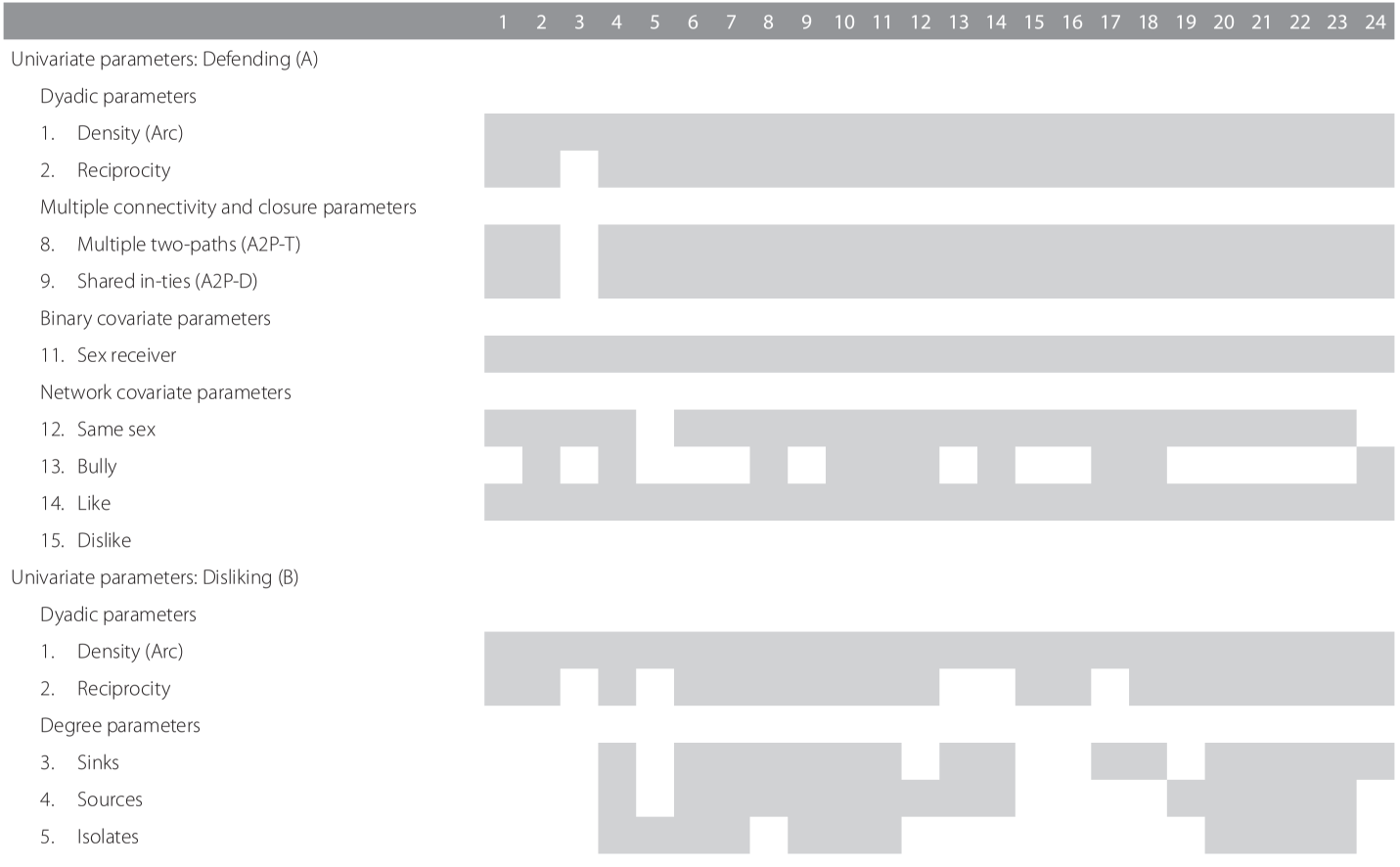
S5.1.1 Overview of the model effects for each classroom network model of defending (A) and liking (B). Classroom 25 thru 48.

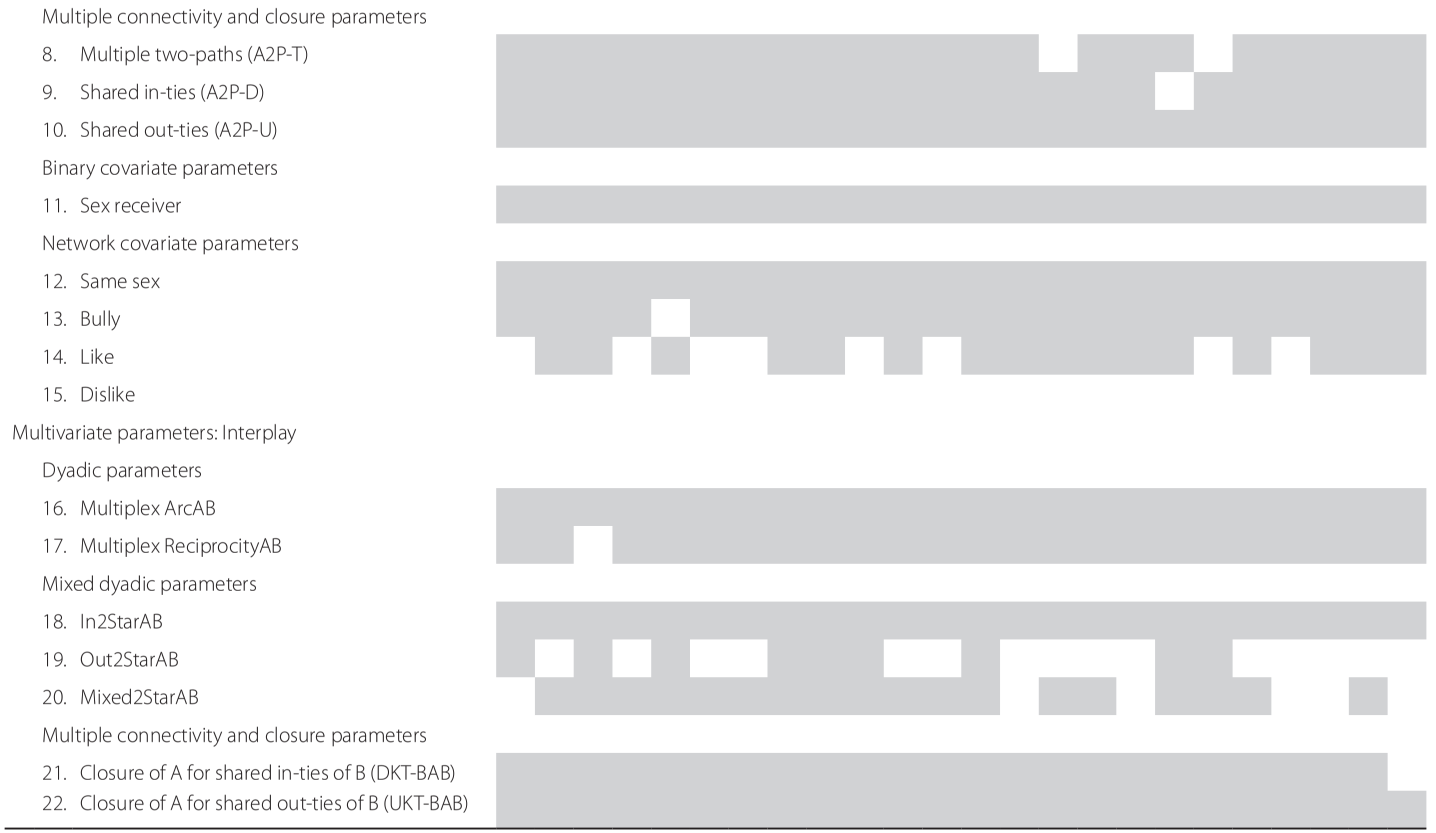




Supplements

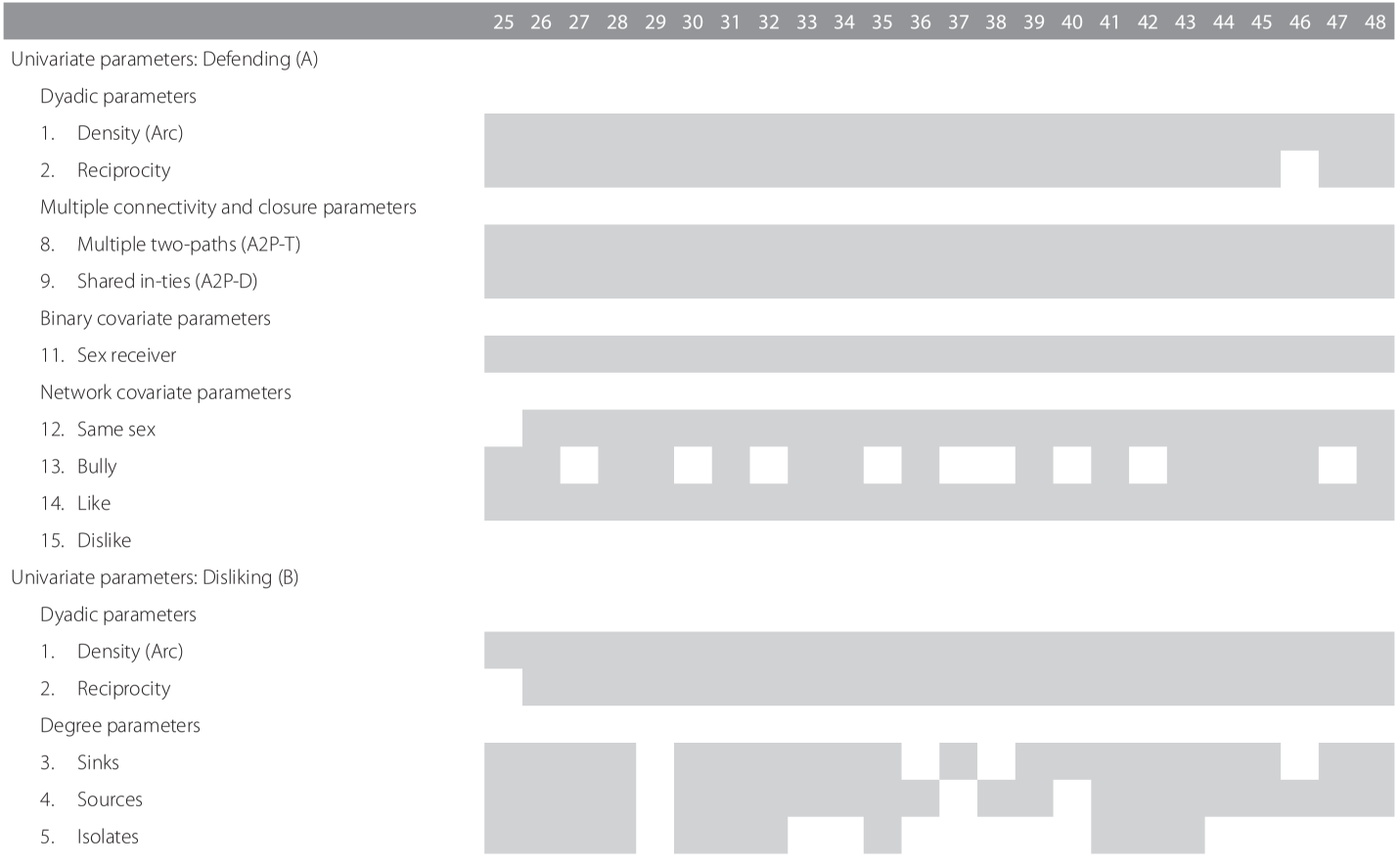
S5.1.2 Overview of the model effects for each classroom network model of defending (A) and disliking (B). Classroom 1 thru 24.

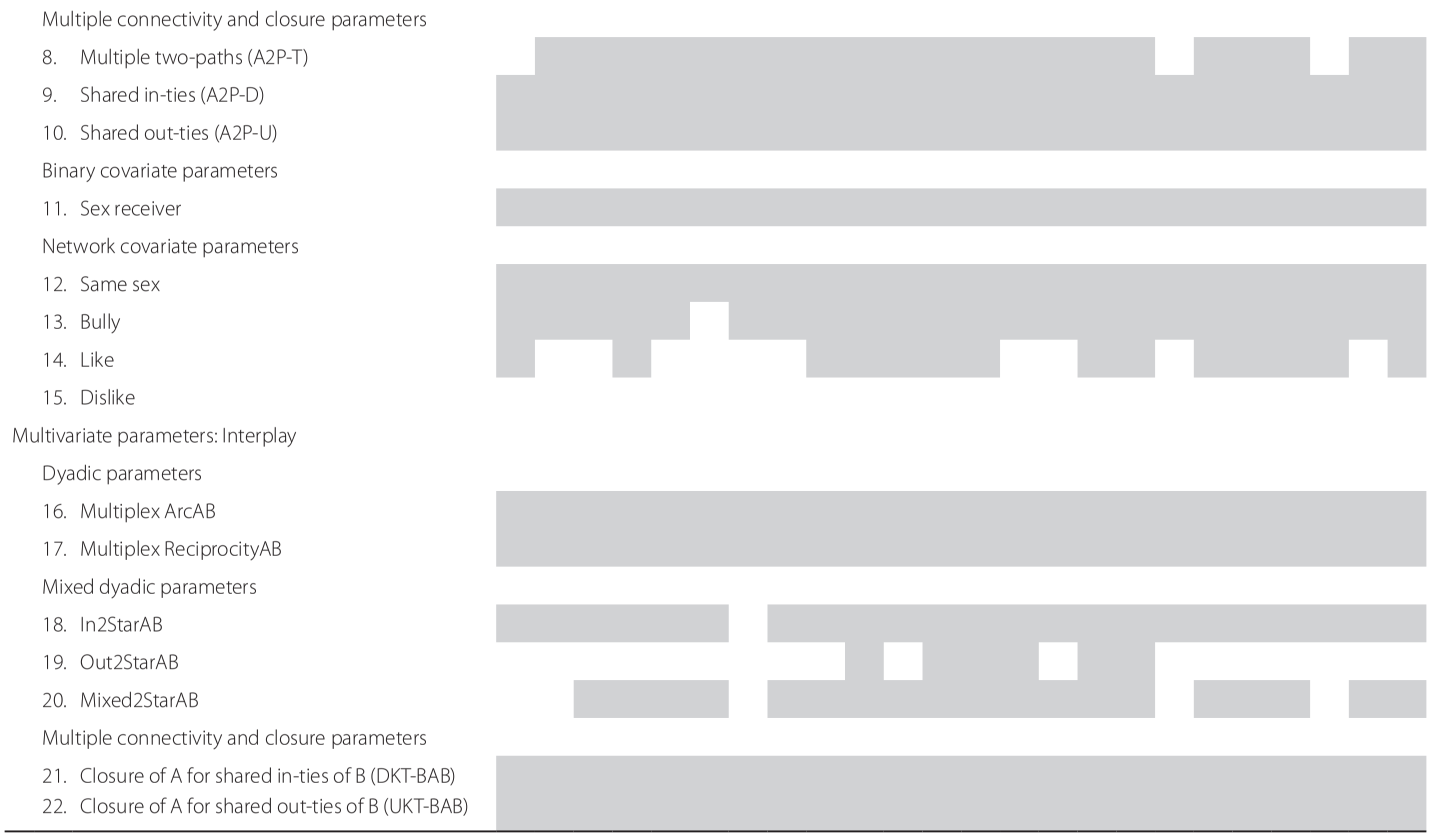




Supplements

S5.1.2 Overview of the model effects for each classroom network model of defending (A) and disliking (B). Classroom 25 thru 48.





Supplements

S5.2.1 Overview of goodness of fit (*t*) statistics for each classroom network model of defending (A) and liking (B) seperately included in this study. Classroom 1 thru 24.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
ArcA	-0.06	-0.01	0.09	-0.13	0.02	-0.11	-0.16	-0.02	-0.06	-0.06	0.10	0.06	-0.05	-0.04	0.45	-0.11	0.07	0.03	0.02	0.04	0.17	-0.07	0.04	-0.01
ReciprocityA	-0.03	-0.10	0.04	-0.10	-0.03	-0.11	-0.16	-0.01	-0.05	-0.04	0.03	0.02	0.03	-0.01	0.53	-0.12	0.05	0.00	0.02	0.01	0.19	-0.03	0.00	-0.02
C2InStarA	-0.03	-0.20	0.14	0.12	-0.30	-0.22	-0.16	0.22	-0.37	-0.39	0.01	-0.40	0.25	-0.04	0.36	-0.38	-0.16	0.06	-0.11	-0.10	0.05	-0.10	-0.04	-0.49
C2OutStarA	-0.05	0.03	0.05	-0.16	-0.03	-0.13	-0.22	0.27	-0.10	0.05	0.15	0.04	0.45	0.06	0.39	-0.22	-0.10	0.22	-0.09	-0.17	0.11	-0.03	-0.02	-0.08
C3InStarA	-0.23	-0.51	0.19	0.69	-0.76	-0.49	-0.17	0.27	-0.61	-0.55	0.08	-0.61	0.50	0.05	0.31	-0.54	-0.32	-0.21	-0.26	-0.30	-0.09	-0.39	0.02	-0.71
C3OutStarA	-0.29	-0.16	0.25	-0.34	-0.38	-0.30	-0.30	0.35	-0.18	-0.05	-0.13	0.04	1.10	-0.16	0.49	-0.04	-0.22	0.07	-0.24	0.09	-0.10	-0.09	0.11	-0.38
Mixed2StarA	-0.15	-0.26	0.04	-0.83	-0.76	-0.13	-0.25	0.11	-0.18	-0.07	0.02	-0.08	-0.68	-0.03	0.36	-0.40	-0.26	0.28	-0.15	-0.32	0.01	-0.15	-0.08	0.00
C030TA	-0.03	-0.26	0.28	0.44	1.68	0.07	-0.11	0.41	0.11	-0.05	0.08	0.11	-0.33	0.88	0.41	-0.17	0.18	0.64	0.05	-0.20	0.21	0.19	0.23	0.12
C030CA	-0.27	-0.43	0.61	-0.84	-0.14	-0.01	-0.51	-0.43	-0.18	-0.10	0.24	-0.59	-1.01	0.33	0.81	-0.46	-0.31	0.49	-0.52	-0.78	-0.08	-0.06	-0.12	-0.69
SinkA	-0.01	0.27	0.67	0.08	1.00	0.86	0.15	0.03	-0.72	-0.19	-0.42	0.43	-0.27	0.41	0.05	0.30	0.54	0.90	0.74	-0.13	0.35	-0.85	-0.88	0.04
SourceA	1.08	0.46	0.17	0.25	0.15	0.77	1.09	4.36	-0.88	-0.19	-0.21	0.26	-0.53	-1.32	-0.64	-0.92	0.25	-0.22	-0.78	-0.21	-0.01	-0.05	-0.19	-1.42
IsoA	0.02	0.34	-0.20	1.41	0.28	-0.11	-0.19	-0.16	0.28	-0.62	-0.06	-0.46	-0.26	1.21	-0.68	-0.64	-0.81	0.56	1.14	-0.14	0.13	0.63	-0.08	0.63
KInStarA	0.05	0.08	0.11	-0.09	-0.12	-0.11	-0.15	0.16	-0.21	-0.30	0.02	-0.20	0.07	-0.09	0.36	-0.27	-0.09	0.17	-0.02	-0.01	0.14	0.03	-0.02	-0.35
KOutStarA	0.06	0.22	0.11	-0.07	0.39	0.01	-0.17	-0.08	-0.07	-0.09	0.20	0.03	-0.21	0.26	0.33	-0.21	-0.03	0.31	0.15	-0.10	0.22	-0.06	0.00	0.11
KLStarA	-0.60	-0.56	-0.08	-0.65	-1.27	-0.67	-0.17	-0.63	0.01	-0.23	-0.09	0.09	0.14	-0.47	0.60	0.51	-0.06	-0.44	-0.30	-0.05	0.00	0.02	0.45	0.04
K1StarA	-0.18	-0.34	-0.09	-0.67	-0.62	-0.24	-0.18	-0.28	-0.10	-0.08	0.21	0.13	-0.67	-0.06	0.45	-0.17	-0.16	0.13	-0.02	-0.16	0.14	-0.10	0.16	0.15
C1LStarA	-0.52	-0.32	0.19	-0.85	-1.26	-0.45	-0.14	-0.13	-0.05	-0.16	-0.24	-0.11	-0.04	-0.21	0.50	-0.10	-0.22	0.18	-0.30	-0.65	-0.16	-0.05	0.12	-0.08
TKTriangleA	0.07	-0.06	0.35	0.41	1.73	0.14	-0.02	0.10	0.27	-0.09	0.18	0.21	-0.58	0.98	0.55	0.09	0.27	0.65	0.31	-0.04	0.35	0.26	0.29	0.27
CKTriangleA	-0.18	-0.28	0.71	-0.85	-0.11	0.09	-0.44	-0.51	-0.10	-0.14	0.27	-0.64	-1.03	0.36	0.86	-0.07	-0.32	0.44	-0.40	-0.70	0.03	-0.07	0.03	-0.73
DKTriangleA	0.01	-0.09	0.17	0.30	1.64	0.04	-0.06	-0.12	0.08	0.02	0.03	0.35	-0.45	0.63	0.36	-0.12	0.24	0.86	0.19	-0.29	0.35	0.21	0.05	0.24
UKTriangleA	-0.21	-0.24	0.17	0.41	1.35	0.05	0.02	0.44	0.20	0.08	0.11	-0.02	0.29	0.94	0.74	0.17	0.38	0.44	0.58	0.25	0.08	0.34	0.57	0.25
TK2PathsA	-0.05	-0.03	0.08	-0.88	-0.91	-0.11	-0.20	0.01	-0.05	-0.05	0.06	0.05	-0.68	-0.03	0.46	-0.12	-0.19	0.02	0.01	-0.01	0.11	-0.04	0.00	-0.02

S5.2.1 Continued.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
DK2PathsA	-0.07	0.07	0.16	-0.29	-0.25	-0.10	-0.17	-0.02	-0.04	0.10	0.13	0.11	0.69	-0.06	0.39	-0.12	-0.01	0.03	0.01	0.04	0.06	-0.01	0.06	-0.03
UK2PathsA	-0.20	-0.19	0.12	0.00	-1.46	-0.49	-0.09	-0.07	-0.47	-0.32	-0.17	-0.51	0.18	-0.35	0.32	-0.37	-0.07	-0.10	-0.19	-0.42	-0.01	-0.06	-0.22	-0.48
RbA1	-0.15	0.32	0.08	-0.12	1.60	-0.04	0.02	0.81	0.21	-1.11	0.65	0.14	0.40	1.05	0.44	0.07	-0.07	-0.16	-0.81	-0.50	-0.27	-0.13	0.77	0.25
RsA1	-0.25	0.84	0.11	-0.12	-0.82	-0.03	0.05	1.33	0.39	-2.05	0.67	0.28	0.66	1.92	0.67	0.22	-0.19	-0.35	-1.09	-0.67	-0.43	-0.24	0.88	-0.04
RrA1	-0.04	-0.13	0.12	-0.10	0.09	-0.06	-0.15	-0.01	-0.03	-0.04	0.09	0.04	-0.08	-0.01	0.13	-0.06	0.06	0.03	0.03	0.05	0.13	0.00	0.02	-0.02
T2u11A1	-1.20	0.00	-0.36	-0.07	-0.84	-1.08	-0.68	0.33	0.10	-0.69	1.15	0.40	0.43	0.12	0.00	0.56	0.20	0.23	-1.27	0.43	-0.54	0.15	0.50	0.27
T1u11A1	-1.21	-0.12	-0.38	0.42	-1.16	-1.08	-0.23	0.18	0.06	-0.92	0.43	0.39	0.24	0.07	0.32	0.91	0.19	0.20	-0.86	0.85	0.06	0.12	0.10	0.24
T1au14A1	-0.32	-0.37	0.03	-0.63	-0.03	0.17	-0.20	0.07	-0.11	-0.20	-0.21	-0.12	-0.36	-0.53	0.03	-0.31	-0.47	-0.21	0.16	-0.15	0.51	0.06	0.06	-0.68
T1au13A1	0.09	0.07	-0.27	-0.46	-1.02	-0.64	-0.27	1.13	-0.10	-0.64	0.78	0.35	0.94	0.55	0.27	-0.06	-0.51	0.09	-0.98	-0.32	-0.56	0.04	0.18	-0.40
T1au12A1	-0.02	0.76	0.12	0.06	-0.49	0.10	-0.12	3.13	0.29	-1.30	0.53	0.09	1.12	2.88	0.72	-0.27	-0.62	0.01	-0.51	-0.55	-0.77	-0.11	0.92	0.06
CovArcA1	-0.07	-0.02	0.05	-0.14	3.96	-0.11	-0.15	-0.02	-0.05	-0.11	0.07	0.04	0.00	-0.01	0.50	-0.12	0.07	0.04	0.03	0.01	0.16	-0.07	0.03	0.35
CovArcA2	-0.74	-0.01	-0.83	-0.04	-1.05	-0.94	-1.78	0.01	-0.69	-0.04	-0.03	-0.02	-1.83	0.02	-1.52	-1.77	0.04	0.02	-1.40	-1.78	-0.88	-1.60	-1.79	-0.04
CovArcA3	-0.05	-0.84	1.92	-0.09	-0.09	-0.94	-1.99	0.04	-0.06	-0.05	-0.96	-2.56	0.05	-1.33	-0.69	-1.90	-1.05	0.00	0.01	-0.03	-1.55	-0.02	0.03	0.04
ArcB	-0.06	0.02	0.14	-0.08	0.20	-0.07	-0.18	-0.05	-0.04	0.13	0.11	0.07	-0.13	-0.04	0.36	-0.12	0.09	0.03	0.03	0.01	0.17	-0.09	0.07	-0.05
ReciprocityB	-0.06	-0.01	0.13	-0.08	0.17	-0.06	-0.19	-0.06	-0.05	0.13	0.11	0.04	-0.12	-0.05	0.38	-0.13	0.09	0.04	0.02	0.01	0.16	-0.08	0.06	-0.04
C2InStarB	-0.06	0.03	0.19	0.02	0.25	-0.07	-0.20	-0.06	0.03	0.25	0.12	0.36	-0.20	-0.04	0.55	0.12	0.20	0.03	0.03	0.00	0.18	-0.08	0.07	0.64
C2OutStarB	-0.07	0.04	0.19	-0.07	0.20	-0.07	-0.19	-0.05	-0.03	0.16	0.10	0.40	-0.11	-0.04	1.31	0.45	0.09	0.02	0.02	0.01	0.17	-0.08	0.06	0.87
C3InStarB	-0.09	0.05	0.22	0.12	0.26	-0.08	-0.24	-0.10	0.06	0.34	0.13	0.55	-0.30	-0.06	0.73	0.38	0.31	0.01	0.01	-0.03	0.18	-0.08	0.04	1.08
C3OutStarB	0.02	0.15	0.45	-0.06	0.15	0.12	-0.23	0.01	0.08	0.27	0.16	1.15	-0.03	0.27	4.01	1.86	0.09	0.05	-0.02	0.07	0.20	-0.04	0.07	2.25
Mixed2StarB	-0.31	-0.15	-0.07	-0.27	0.12	-0.27	-0.26	-0.25	-0.11	-0.05	0.10	0.28	-0.41	-0.24	0.27	-0.15	0.04	-0.16	-0.15	-0.23	0.09	-0.19	-0.06	-0.09
C030TB	-0.09	0.08	0.22	-0.12	0.24	-0.06	-0.22	-0.11	0.06	0.20	0.17	0.76	-0.20	0.07	1.05	0.34	0.22	-0.07	-0.04	-0.07	0.19	-0.10	0.01	0.77
C030CB	-0.55	-0.27	-0.15	-0.40	0.10	-0.47	-0.33	-0.40	-0.06	-0.11	0.07	0.61	-0.59	-0.29	0.19	-0.15	-0.01	-0.28	-0.31	-0.30	0.08	-0.25	-0.18	-0.51
SinkB	-0.46	-0.05	-0.49	-0.03	-0.54	-0.55	-0.22	-0.30	-0.23	-0.56	-0.08	-0.47	-0.10	-0.55	-1.09	-0.44	-0.39	-0.39	-0.34	-0.74	-1.00	-0.27	-1.00	-1.01

Supplements

S5.2.1 Continued.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
SourceB	-0.18	-1.00	-1.00	-1.00	-0.29	-1.00	-1.00	-0.13	-1.00	-0.08	-1.00	-0.03	-0.20	-1.00	-1.00	-1.00	-0.06	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
IsoB	-0.08	-1.00	-1.00	-1.00	-0.10	-1.00	-1.00	-0.05	-1.00	-1.00	-1.00	-1.00	-0.05	-1.00	-1.00	-1.00	-0.03	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
KInStarB	-0.06	0.02	0.14	-0.08	0.21	-0.07	-0.18	-0.04	-0.04	0.14	0.11	0.13	-0.12	-0.04	0.36	-0.11	0.09	0.03	0.03	0.01	0.17	-0.09	0.07	0.05
KOutStarB	-0.09	0.01	0.14	-0.07	0.21	-0.09	-0.17	-0.07	-0.04	0.14	0.10	0.06	-0.14	-0.08	0.31	-0.14	0.10	0.05	0.04	0.00	0.17	-0.08	0.07	-0.07
KLStarB	0.43	0.28	0.23	-0.69	-0.13	0.60	-0.94	-0.05	-0.30	-0.45	0.52	-0.53	-0.06	1.10	1.24	0.25	0.05	-0.11	-0.41	0.14	0.24	-0.32	-0.48	-0.58
K1StarB	-0.11	0.01	0.13	-0.08	0.05	-0.08	-0.20	-0.24	-0.06	0.04	0.11	-0.01	-0.18	-0.04	0.35	-0.16	0.09	0.04	0.00	-0.03	0.17	-0.08	0.06	-0.42
C1LStarB	-0.13	0.00	0.10	-0.14	0.17	-0.05	-0.28	-0.07	-0.10	0.07	0.16	0.10	-0.12	0.14	0.59	-0.10	-0.01	-0.06	-0.14	-0.03	0.18	-0.10	0.06	-0.21
TKTriangleB	0.17	0.11	0.26	0.00	0.26	0.04	-0.13	0.01	0.04	0.37	0.11	0.50	-0.05	0.06	0.48	0.11	0.10	0.07	0.12	0.15	0.18	-0.05	0.11	0.28
CKTriangleB	-0.31	-0.05	0.09	-0.15	0.14	-0.14	-0.22	-0.30	-0.02	0.11	0.10	0.42	-0.26	-0.02	0.38	-0.15	-0.02	-0.08	-0.16	-0.04	0.16	-0.05	0.04	-0.38
DKTriangleB	-0.05	0.07	0.18	-0.08	0.11	-0.06	-0.18	-0.13	-0.05	0.12	0.12	0.45	-0.12	-0.03	0.41	0.07	0.07	0.00	0.03	-0.02	0.16	-0.06	0.08	0.24
UKTriangleB	0.12	0.03	0.25	-0.03	0.29	0.09	-0.18	0.04	0.03	0.37	0.19	0.55	-0.01	0.19	0.65	0.05	0.01	0.05	0.08	0.19	0.21	-0.03	0.08	0.29
TK2PathsB	-0.05	0.00	0.10	-0.09	0.20	-0.07	-0.15	-0.05	-0.06	0.05	0.10	0.05	-0.16	-0.02	0.24	-0.13	0.10	0.02	0.02	0.01	0.14	-0.11	0.08	-0.07
DK2PathsB	-0.06	0.01	0.08	-0.04	0.21	-0.07	-0.12	-0.03	-0.03	0.04	0.19	0.06	-0.15	-0.02	0.29	-0.10	0.10	0.00	0.02	0.04	0.13	-0.12	0.06	-0.03
UK2PathsB	-0.04	-0.01	0.10	-0.11	0.19	-0.06	-0.15	-0.05	-0.06	0.08	0.11	0.05	-0.16	-0.02	0.38	-0.11	0.09	0.02	0.04	0.01	0.15	-0.08	0.09	-0.05
RbB1	2.79	0.33	-0.63	1.56	-0.11	-0.53	-0.11	0.34	-0.22	-0.46	-0.59	0.19	1.90	0.09	0.58	-0.37	0.39	-0.07	-0.57	-0.89	-0.30	-0.79	0.56	-0.13
RsB1	4.93	0.37	-0.89	1.51	-0.10	-0.74	-0.12	0.33	-0.22	-0.72	-0.55	0.36	1.40	0.10	0.79	-0.62	0.34	-0.13	-0.66	-0.98	-0.28	-0.87	0.48	-0.19
RrB1	-0.05	-0.08	0.14	-0.07	0.19	-0.04	-0.18	-0.04	-0.02	0.10	0.12	0.04	-0.13	-0.03	0.13	-0.07	0.09	0.04	0.03	0.00	0.15	-0.07	0.06	-0.04
T2u11B1	2.38	0.69	-0.10	1.23	-0.46	-0.22	-0.20	0.14	0.07	-0.51	-0.50	0.36	1.80	0.17	0.48	-0.25	0.62	-0.15	-0.86	-0.62	-0.19	-0.47	0.47	0.47
T1u11B1	1.93	0.13	0.00	0.26	-0.16	-0.11	-0.16	0.07	-0.02	-0.16	-0.38	0.69	0.53	0.10	0.52	-0.18	0.20	-0.01	-0.43	-0.52	-0.08	-0.29	0.14	0.51
T1au14B1	-0.21	-0.21	0.26	0.02	0.05	-0.01	-0.16	-0.04	0.04	0.21	0.16	0.29	-0.29	0.00	0.19	-0.03	0.35	-0.10	0.04	0.07	0.31	0.03	0.04	0.57
T1au13B1	1.89	0.14	-0.50	0.48	-0.11	-0.48	-0.23	0.02	-0.24	-0.39	-0.36	0.40	0.36	-0.21	0.32	-0.44	0.23	-0.29	-0.56	-0.82	-0.16	-0.41	0.12	-0.24
T1au12B1	12.97	0.25	-0.93	1.74	-0.05	-0.81	-0.17	0.38	-0.02	-0.63	-0.63	0.87	1.45	0.23	1.58	-0.75	0.19	0.11	-0.65	-1.08	-0.27	-0.87	0.43	-0.75
CovArcB1	-0.06	0.00	0.09	-0.09	0.19	-0.06	-0.17	-0.05	-0.05	0.07	0.11	0.03	-0.14	-0.02	0.45	-0.13	0.09	0.06	0.03	0.01	0.17	-0.10	0.07	-0.02

S5.2.1 Continued.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
CovArcB2	-0.04	-0.08	0.05	-0.02	0.17	-0.10	-0.16	0.06	0.02	-2.19	0.02	0.04	-0.04	-0.02	0.27	-0.07	0.08	0.04	0.08	-0.02	0.13	-0.08	0.06	0.02
CovArcB3	-3.43	-0.01	0.13	-4.37	0.06	-0.02	-3.01	-0.01	-0.03	-3.45	0.00	-5.41	-0.06	0.00	0.17	-0.09	-0.01	-0.01	-3.02	-0.09	-3.22	-0.03	0.07	-0.02
ArcAB	-0.05	-0.02	0.05	-0.12	0.12	-0.11	-0.17	-0.01	-0.06	-0.07	0.10	0.01	-0.12	-0.03	0.48	-0.12	0.06	0.05	0.03	0.05	0.18	-0.11	0.05	-0.01
ReciprocityAB	-0.06	-0.02	0.10	-0.13	0.11	-0.09	-0.17	-0.05	-0.07	-0.03	0.13	0.03	-0.11	-0.01	0.47	-0.12	0.08	0.03	0.02	-0.03	0.17	-0.08	0.05	-0.02
ReciprocityAAB	0.15	-0.08	0.11	-0.18	-0.68	-0.05	-0.26	0.10	-0.13	0.14	0.03	-0.47	0.07	-0.33	0.55	-0.20	-0.03	0.25	0.00	-0.37	0.20	-0.36	-0.04	0.07
ReciprocityABB	-0.13	-0.05	0.26	-0.20	0.06	-0.07	-0.27	-0.09	-0.11	0.10	0.13	-0.13	0.01	-0.18	0.46	-0.09	0.15	0.28	-0.11	-0.21	0.22	-0.29	0.17	-0.22
ReciprocityAABB	0.30	-0.06	0.17	-0.27	-1.36	0.01	-0.38	0.11	-0.21	0.21	0.03	-0.57	0.04	-0.64	0.56	-0.13	-0.12	0.78	-0.04	-1.23	0.22	-0.70	0.18	0.14
In2StarAB	-0.06	-0.02	0.15	-0.12	0.16	-0.10	-0.18	-0.05	-0.05	0.03	0.11	0.08	-0.12	-0.04	0.48	-0.11	0.07	0.04	0.03	0.02	0.17	-0.09	0.06	-0.01
Out2StarAB	-0.05	0.06	0.09	-0.13	0.15	-0.11	-0.18	-0.01	-0.04	-0.01	0.12	0.03	-0.14	-0.06	0.40	-0.11	0.06	0.06	0.03	0.04	0.17	-0.12	0.06	-0.03
Mixed2StarAB	-0.07	0.04	0.15	-0.12	0.14	-0.09	-0.18	-0.05	-0.06	0.02	0.11	0.07	-0.12	-0.02	0.40	-0.11	0.07	0.04	0.02	0.01	0.17	-0.07	0.06	-0.01
Mixed2StarBA	-0.25	-0.26	-0.50	-0.43	-0.02	-0.13	-0.27	-0.43	-0.14	-0.49	0.11	0.45	-0.43	-0.11	0.24	-0.25	-0.11	-0.31	-0.28	-0.33	0.21	-0.20	-0.20	-0.24
TABA	-0.04	-0.23	0.23	-0.54	-0.15	-0.16	-0.25	-0.15	-0.03	0.44	-0.02	-0.01	-0.56	0.25	0.45	-0.24	-0.23	0.34	-0.04	-0.06	0.26	-0.22	0.07	0.45
TABB	0.10	0.15	0.14	-0.08	0.12	-0.12	-0.19	0.09	0.04	0.16	0.22	0.04	-0.35	-0.04	0.66	-0.02	0.26	0.24	0.06	-0.03	0.20	-0.23	0.12	0.30
TBBA	0.05	0.13	0.04	-0.15	0.28	0.11	-0.19	-0.23	0.11	0.34	0.30	0.75	-0.11	0.18	0.88	0.07	0.12	-0.08	-0.10	0.08	0.30	-0.04	-0.03	0.39
TBAB	-0.13	0.00	0.09	-0.19	0.19	-0.20	-0.23	-0.21	0.10	0.01	0.09	0.22	-0.43	0.11	0.58	-0.17	0.13	-0.16	-0.02	-0.15	0.21	-0.14	0.05	-0.23
TAAB	-0.06	0.00	0.14	0.02	0.32	-0.13	-0.22	0.34	-0.05	0.12	0.17	0.02	-0.05	0.06	0.50	-0.18	-0.05	0.30	-0.03	0.10	0.19	-0.04	0.06	-0.10
TBAA	0.13	-0.11	0.02	-0.08	0.57	-0.01	-0.23	-0.10	-0.13	-0.22	0.23	0.12	-0.32	0.16	0.48	-0.22	-0.09	-0.03	-0.13	-0.12	0.17	-0.05	-0.06	-0.09
CAAB	-0.42	-0.21	0.00	-0.69	-0.29	-0.26	-0.32	-0.13	-0.19	-0.08	0.08	-0.09	-0.62	-0.10	0.51	-0.33	-0.36	0.24	-0.33	-0.54	0.12	-0.33	-0.25	-0.14
CBBA	-0.35	-0.17	-0.25	-0.42	0.14	-0.34	-0.30	-0.42	-0.12	-0.18	0.12	0.31	-0.48	-0.15	0.31	-0.23	-0.09	-0.15	-0.28	-0.26	0.21	-0.27	-0.20	-0.41
IsoAB	-0.06	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
TKTABA	0.05	0.01	0.32	-0.51	-0.24	-0.19	-0.21	-0.25	0.11	0.49	0.03	0.14	-0.73	0.35	0.58	0.03	-0.16	0.34	0.12	0.17	0.42	-0.13	0.20	0.58
CKTABA	-0.34	0.06	0.11	-0.74	-0.36	-0.27	-0.26	-0.16	-0.07	-0.02	0.05	0.05	-0.61	-0.02	0.65	-0.11	-0.28	-0.01	-0.24	-0.49	0.23	-0.23	-0.16	-0.09
DKTABA	-0.07	0.06	0.17	-0.12	0.13	-0.10	-0.17	-0.05	-0.04	0.13	0.12	0.08	-0.10	-0.06	0.46	-0.12	0.06	0.04	0.02	0.01	0.17	-0.05	0.07	-0.03

S5.2.1 Continued.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
UKTABA	-0.05	-0.11	0.08	-0.12	0.06	-0.12	-0.18	-0.01	-0.06	-0.06	0.08	0.03	-0.08	-0.04	0.56	-0.12	0.05	0.05	0.06	0.03	0.17	-0.09	0.03	0.00
TKTBAB	0.05	0.01	0.32	-0.51	-0.24	-0.19	-0.21	-0.25	0.11	0.49	0.03	0.14	-0.73	0.35	0.58	0.03	-0.16	0.34	0.12	0.17	0.42	-0.13	0.20	0.58
CKTBAB	-0.34	0.06	0.11	-0.74	-0.36	-0.27	-0.26	-0.16	-0.07	-0.02	0.05	0.05	-0.61	-0.02	0.65	-0.11	-0.28	-0.01	-0.24	-0.49	0.23	-0.23	-0.16	-0.09
DKTBAB	-0.07	0.06	0.17	-0.12	0.13	-0.10	-0.17	-0.05	-0.04	0.13	0.12	0.08	-0.10	-0.06	0.46	-0.12	0.06	0.04	0.02	0.01	0.17	-0.05	0.07	-0.03
UKTBAB	-0.05	-0.11	0.08	-0.12	0.06	-0.12	-0.18	-0.01	-0.06	-0.06	0.08	0.03	-0.08	-0.04	0.56	-0.12	0.05	0.05	0.06	0.03	0.17	-0.09	0.03	0.00
mrs1	-0.83	-0.07	-0.03	0.08	0.35	0.01	0.03	0.25	-0.06	-0.43	0.09	0.46	-0.12	0.01	0.12	0.16	0.18	-0.03	0.21	0.00	0.10	0.20	0.48	-0.14
mrs1	-0.83	-0.07	-0.03	0.08	0.35	0.01	0.03	0.25	-0.06	-0.43	0.09	0.46	-0.12	0.01	0.12	0.16	0.18	-0.03	0.21	0.00	0.10	0.20	0.48	-0.14
exab1	-0.27	0.76	-0.50	-0.26	-0.34	0.05	-0.08	0.15	-0.24	-1.65	0.38	0.68	1.55	1.77	0.47	0.40	0.22	-0.14	-1.29	-0.09	-0.40	-0.58	0.38	0.32
exba1	0.99	1.83	1.54	0.29	-1.09	-0.28	-2.03	1.27	0.69	1.91	1.14	1.67	-2.86	1.03	2.20	1.39	-1.40	-2.87	0.52	-1.51	1.75	2.91	3.06	-0.66
mrb1	-1.05	0.35	0.03	-0.01	1.66	0.02	0.31	0.52	0.16	-0.90	0.65	0.49	-0.13	1.01	0.41	0.24	0.02	-0.41	-0.62	-0.31	-0.22	0.03	1.05	-0.01
mrbm1	-0.24	0.38	-0.33	-0.23	0.65	0.08	-0.09	0.30	-0.20	-1.41	0.08	0.29	1.35	1.22	0.29	0.14	0.32	-0.01	-1.45	-0.01	-0.34	-0.59	0.51	0.36
CovArcAB1	-0.10	0.04	0.20	-0.24	2.99	-0.12	-0.21	-0.06	-0.08	-0.05	0.07	-0.15	-0.49	-0.11	0.50	-0.15	0.05	-0.28	0.11	0.23	0.21	-0.05	0.51	0.16
CovArcAB2	-0.50	0.06	-0.58	0.46	-1.00	-0.92	-1.28	0.57	-0.54	-0.98	-0.03	0.29	-1.23	0.45	-1.50	-1.62	0.29	0.63	-1.12	-1.16	-0.77	-1.51	-1.43	-0.76
CovArcAB3	-1.32	-0.66	1.27	-0.97	0.87	-0.56	-1.56	-0.59	0.26	-1.29	-0.96	-2.06	-0.42	-0.61	-0.46	-0.82	-0.57	-0.41	-1.47	-0.29	-1.51	-0.50	-0.54	-0.69

Notes. Gray cells indicate that fit was poor. Yellow cells indicate that fit was poor, but an accompanying statistic was not there (or they were too few). This suggest that the model expected more observations by chance than there actually were. Orange cells indicate that the observed statistic was equal to the total number of ties in the network, and could therefore not be included. This happened sometimes for CovArcA1, referring to same-sex.

S5.2.1 Overview of goodness of fit (*t*) statistics for each classroom network model of defending (A) and liking (B) seperately included in this study. Classroom 25 thru 48.

	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
ArcA	0.00	-0.01	0.02	-0.12	-0.03	0.56	-0.05	0.09	0.02	0.15	-0.04	0.16	-0.36	-0.05	0.13	0.08	-0.10	0.01	0.01	0.06	0.06	0.22	0.03	0.03
ReciprocityA	-0.01	-0.03	-0.01	0.03	0.02	0.39	-0.04	-0.05	0.04	0.00	-0.03	0.14	-0.34	0.02	0.12	0.07	-0.02	-0.03	0.01	0.04	0.06	-1.03	0.05	0.03
C2InStarA	-0.47	0.17	0.16	-0.02	0.02	1.00	-0.14	-0.41	0.37	0.12	0.05	0.19	-0.45	-0.06	-0.09	-0.13	-0.15	-0.31	0.21	0.07	0.05	-0.06	0.00	-0.03
C2OutStarA	0.49	0.12	0.17	0.00	-0.20	0.81	-0.13	0.54	0.06	0.11	0.13	0.22	-0.45	0.14	-0.03	0.25	-0.19	0.26	0.16	0.15	0.06	0.14	0.05	-0.02
C3InStarA	-0.73	0.25	0.12	0.15	-0.12	0.92	-0.22	-0.80	0.98	0.05	-0.21	0.11	-0.48	-0.16	-0.21	-0.54	0.06	-0.30	0.53	-0.10	-0.10	-0.16	-0.07	-0.14
C3OutStarA	0.44	-0.06	0.06	0.02	-0.39	0.51	-0.17	0.28	-0.02	-0.03	-0.14	0.20	-0.47	0.12	-0.16	0.19	-0.34	0.21	0.29	0.05	-0.07	-0.08	0.01	-0.25
Mixed2StarA	0.19	-0.06	-0.12	-0.09	-0.14	0.79	-0.20	-0.11	0.10	-0.08	-0.12	0.02	-0.44	-0.09	-0.09	0.11	-0.22	-0.02	0.00	-0.06	0.03	0.21	0.03	-0.18
C030TA	1.17	0.66	0.12	0.23	-0.27	1.45	-0.12	0.50	0.66	0.24	0.61	0.30	-0.44	0.21	-0.06	0.39	-0.07	0.35	0.33	0.18	0.35	1.24	0.65	-0.24
C030CA	0.67	-0.27	-0.39	0.21	-0.40	1.23	-0.32	-0.23	-1.05	0.30	-0.79	-0.07	-0.47	0.11	-0.26	-0.52	-0.44	0.19	0.19	-0.61	-0.40	-0.20	0.12	-0.65
SinkA	1.55	0.41	0.63	-0.40	-0.10	0.88	-0.51	0.72	-1.13	0.93	-0.55	-0.17	0.12	-0.01	-0.36	-1.01	0.24	1.22	0.25	0.01	0.91	0.81	0.85	0.20
SourceA	-0.09	0.59	1.27	-0.66	1.22	2.14	-0.67	1.70	-1.77	-0.83	-0.87	1.16	0.52	-0.06	-0.45	0.96	-0.29	-0.24	-0.13	-0.85	1.52	0.44	0.35	-0.05
IsoA	-1.58	-0.76	-0.12	-0.63	0.33	-0.15	0.82	-0.15	1.28	0.93	1.15	-0.17	-0.83	-1.00	-0.59	0.88	-0.74	-0.27	-0.03	1.43	-0.79	-0.74	-0.37	-0.47
KInStarA	-0.26	0.07	0.15	-0.14	0.09	0.94	-0.06	0.01	0.05	0.14	0.16	0.21	-0.40	-0.03	0.02	0.17	-0.22	-0.27	0.03	0.14	0.11	-0.03	0.04	0.00
KOutStarA	0.26	0.09	0.10	-0.16	-0.02	0.77	-0.09	0.35	0.04	0.29	0.31	0.18	-0.41	0.05	0.09	0.14	-0.09	0.26	0.05	0.11	0.13	0.21	0.09	0.09
KLStarA	-0.04	-0.11	-0.70	-0.02	-0.18	-0.81	0.37	-1.04	0.61	-0.03	-0.20	-0.07	0.15	-0.58	0.33	-0.70	-0.13	-0.29	-0.20	0.28	-0.43	0.16	-0.40	-0.35
K1StarA	0.35	0.10	-0.10	-0.09	-0.12	0.22	-0.08	-0.82	0.38	-0.01	-0.11	0.13	-0.40	-0.43	0.10	-0.14	-0.05	-0.10	0.04	0.13	0.03	0.22	-0.05	-0.23
C1LStarA	-0.21	0.02	-0.65	-0.27	-0.04	0.04	0.06	-0.33	0.10	-0.09	-0.17	0.01	-0.32	-0.31	0.01	-0.09	-0.42	-0.11	0.00	0.09	-0.22	0.19	-0.18	-0.22
TKTriangleA	1.23	0.72	0.23	0.15	-0.18	1.30	0.01	0.97	0.51	0.49	0.86	0.44	-0.38	0.17	0.13	0.49	0.10	0.38	0.21	0.28	0.59	1.29	0.79	-0.19
CKTriangleA	0.98	-0.23	-0.33	0.32	-0.37	1.07	-0.31	-0.18	-1.11	0.49	-0.89	0.09	-0.53	-0.04	-0.10	-0.53	-0.36	0.30	0.26	-0.52	-0.31	-0.20	0.10	-0.69
DKTriangleA	0.97	0.44	0.11	0.19	-0.12	1.24	0.02	-0.21	0.60	0.17	0.61	0.22	-0.42	-0.11	0.10	0.09	0.01	0.38	0.12	0.13	0.34	1.33	0.48	-0.30
UKTriangleA	0.57	0.57	-0.11	-0.04	-0.03	0.83	0.03	-0.08	0.65	0.58	0.58	0.45	-0.33	0.03	0.14	0.28	0.10	0.15	0.28	0.41	0.69	1.03	0.80	-0.19
TK2PathsA	-0.01	-0.01	0.00	-0.10	-0.02	0.61	-0.05	-0.01	0.03	0.10	-0.01	0.16	-0.36	0.02	0.13	0.08	-0.09	-0.01	0.01	0.05	0.06	0.12	0.03	0.02

Supplements

S5.2.1 Continued.

	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
DK2PathsA	0.00	0.04	0.01	-0.15	-0.01	0.59	-0.03	0.01	0.01	0.18	0.03	0.15	-0.31	-0.09	0.12	0.09	-0.13	0.10	-0.01	0.02	0.07	0.17	0.03	0.03
UK2PathsA	-1.33	-0.10	0.07	-0.17	0.40	0.59	-0.10	-1.45	0.34	0.00	-0.25	0.07	-0.26	-0.45	-0.01	-0.82	-0.02	-0.56	0.15	-0.19	-0.04	-0.04	-0.25	-0.01
RbA1	0.34	0.27	0.26	-0.83	-0.06	0.75	-0.09	2.41	0.27	0.04	-0.05	0.00	0.19	0.05	0.08	0.53	-0.37	0.09	0.09	0.22	1.47	-0.01	-0.16	-0.16
RsA1	-1.57	0.54	0.32	-1.06	-0.13	1.16	-0.23	1.70	0.27	0.01	-0.02	-0.10	0.14	0.00	0.03	0.78	-0.56	0.17	0.12	0.29	2.30	-0.08	-0.48	-0.37
RrA1	0.02	-0.01	0.02	-0.21	-0.01	0.44	0.01	-0.05	0.04	0.08	-0.06	0.14	0.22	0.03	0.11	0.06	-0.09	0.01	0.00	0.08	0.07	0.18	0.06	0.03
T2u11A1	1.14	-0.41	0.44	-0.37	0.30	1.48	-0.24	-0.19	1.88	0.14	0.93	0.05	0.05	0.45	-0.25	0.41	0.02	0.70	0.80	1.06	2.30	-0.36	0.12	0.24
T1u11A1	0.80	-0.43	1.06	-0.49	0.28	1.76	-0.24	-0.66	0.59	0.14	0.93	-0.01	0.05	0.38	-0.27	0.05	-0.13	0.70	1.23	0.99	1.72	-0.40	-0.07	0.23
T1au14A1	-0.27	-0.54	1.06	-0.20	-0.03	1.06	-0.31	0.24	-0.22	0.10	-0.33	0.15	-0.32	0.40	0.08	-0.07	-0.03	-0.43	0.12	0.19	-0.28	0.40	0.02	0.19
T1au13A1	-0.17	-0.17	-0.21	-0.76	-0.01	1.96	-0.32	-0.63	1.40	0.54	0.53	-0.10	0.02	-0.05	-0.10	1.07	-0.38	0.26	0.43	0.71	1.56	-0.29	-0.17	-0.20
T1au12A1	-1.39	0.92	-0.14	-1.08	-0.46	0.93	-0.06	1.94	0.32	0.51	1.18	-0.33	0.57	-0.08	-0.05	0.65	-0.51	0.23	0.07	0.93	3.90	-0.26	-0.16	-0.44
CovArcA1	1.51	-0.03	0.02	-0.03	-0.01	0.37	-0.04	-0.06	0.00	0.15	-0.05	0.15	-0.36	-0.01	0.14	0.10	-0.07	0.00	0.02	0.06	0.06	0.17	0.05	0.04
CovArcA2	0.04	0.02	-1.30	-0.15	-0.01	-1.48	-0.02	-0.50	0.01	0.03	-1.23	0.07	-0.49	-1.46	0.03	-1.66	-0.01	-0.79	0.04	0.02	0.01	0.06	-0.78	0.00
CovArcA3	-0.02	-2.13	-1.07	-2.28	-2.66	-2.35	-1.65	0.19	-1.55	0.01	-1.45	0.07	-0.13	-0.03	0.06	0.02	-0.02	-1.57	-2.12	-2.09	-1.49	-0.75	-0.04	-1.51
ArcB	-0.04	0.01	0.02	-0.15	0.00	0.86	-0.03	0.08	0.01	0.18	0.09	0.17	-0.35	-0.13	0.13	0.08	-0.13	0.08	0.00	0.05	0.06	0.27	0.03	0.00
ReciprocityB	-0.02	0.01	0.02	-0.17	0.00	1.07	-0.02	0.06	0.02	0.17	0.10	0.18	-0.35	-0.14	0.13	0.09	-0.14	0.12	0.00	0.05	0.05	0.27	0.03	-0.01
C2InStarB	0.11	0.40	0.02	-0.14	0.42	1.08	0.07	0.21	0.01	0.16	0.10	0.18	-0.21	-0.13	0.31	0.08	-0.14	0.10	0.00	0.04	0.05	0.27	0.61	0.54
C2OutStarB	-0.01	0.45	0.02	-0.16	0.66	1.10	0.61	0.08	0.02	0.17	0.10	0.17	0.10	-0.14	0.38	0.08	-0.14	0.09	0.00	0.04	0.06	0.27	0.95	2.42
C3InStarB	0.30	0.69	0.00	-0.14	0.78	1.28	0.10	0.32	0.01	0.14	0.07	0.15	-0.21	-0.18	0.43	0.01	-0.19	0.18	-0.01	-0.05	0.02	0.30	1.24	0.78
C3OutStarB	0.46	1.76	0.04	-0.09	1.71	1.23	2.09	0.25	0.16	0.20	0.12	0.16	0.87	-0.11	0.75	0.14	-0.15	0.14	0.05	0.04	0.14	0.29	3.23	5.81
Mixed2StarB	-0.73	0.08	-0.07	-0.37	-0.07	0.79	-0.04	-0.17	-0.13	0.10	-0.09	0.11	-0.38	-0.27	0.11	-0.01	-0.22	-0.08	0.01	0.01	-0.12	0.13	0.21	-0.83
C030TB	-0.23	0.86	0.03	-0.17	0.62	1.14	0.40	0.08	0.03	0.18	0.05	0.22	-0.13	-0.15	0.36	0.12	-0.13	0.24	0.06	0.09	0.07	0.26	1.43	0.98
C030CB	-1.20	0.26	-0.11	-0.56	-0.31	0.66	-0.07	-0.42	-0.21	0.08	-0.23	0.08	-0.39	-0.33	-0.07	-0.05	-0.24	-0.04	0.04	-0.08	-0.20	-0.01	0.70	-1.23
SinkB	-0.69	-0.93	-0.94	-0.42	-0.73	-0.05	-1.00	-0.11	-1.00	1.34	-0.53	-0.43	-0.50	-0.55	-0.37	-0.73	-1.00	-0.21	0.36	-1.03	-0.99	-0.19	-0.57	-0.85

S5.2.1 Continued.

	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
SourceB	-1.00	-1.00	-1.00	-1.00	-0.03	-1.00	-1.00	-1.00	-1.00	-0.11	-1.00	-0.10	-1.00	-0.09	-0.18	-0.14	-0.25	-0.22	-1.00	-0.40	-1.00	-1.00	-1.00	-1.00
IsoB	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-0.05	-1.00	-0.08	-1.00	-0.03	-1.00	-1.00	-1.00	-0.07	-1.00	5.59	-1.00	-1.00	-1.00	-1.00
KInStarB	-0.04	0.05	0.03	-0.15	0.09	0.87	-0.03	0.08	0.01	0.18	0.09	0.18	-0.34	-0.12	0.17	0.09	-0.13	0.07	0.00	0.09	0.06	0.27	0.05	0.03
KOutStarB	-0.13	-0.13	0.02	-0.16	0.03	0.88	-0.10	0.06	0.00	0.18	0.10	0.16	-0.37	-0.14	0.13	0.07	-0.13	0.06	0.01	0.05	0.05	0.29	-0.04	-0.15
KLStarB	0.87	1.02	0.10	-0.03	-0.73	-0.46	0.87	0.64	0.50	0.09	-0.43	0.18	0.15	-0.38	-0.68	0.26	-0.35	0.40	-0.24	0.06	0.20	-0.22	0.63	1.21
K1StarB	-0.09	-0.08	0.02	-0.17	-0.11	0.85	-0.04	0.05	0.01	0.18	0.07	0.16	-0.44	-0.33	-0.12	0.02	-0.16	0.05	0.00	0.06	0.04	0.28	-0.03	-0.35
C1LStarB	0.14	0.50	-0.03	-0.16	-0.20	0.68	0.28	0.17	0.04	0.21	-0.10	0.17	-0.29	-0.14	0.10	0.17	-0.14	0.02	-0.08	0.10	0.05	0.15	0.31	0.58
TKTriangleB	0.38	0.57	0.11	-0.03	0.54	0.92	0.04	0.18	0.04	0.28	0.17	0.21	-0.22	0.01	0.46	0.17	-0.06	0.36	0.03	0.26	0.22	0.33	0.35	0.27
CKTriangleB	-0.47	0.80	0.05	-0.30	-0.04	0.60	0.13	0.00	-0.01	0.28	-0.05	0.14	-0.38	-0.20	0.11	0.11	-0.12	0.18	-0.02	0.14	0.04	0.22	0.50	-0.25
DKTriangleB	-0.17	0.41	0.06	-0.19	0.36	0.84	-0.02	0.05	0.02	0.24	0.08	0.17	-0.31	-0.20	0.31	0.09	-0.13	0.32	0.00	0.24	0.11	0.29	0.17	0.04
UKTriangleB	0.65	1.02	0.10	0.02	0.46	0.83	0.37	0.37	0.15	0.32	0.08	0.23	-0.20	0.03	0.39	0.24	-0.08	0.24	0.00	0.33	0.25	0.22	0.75	0.77
TK2PathsB	-0.06	0.02	0.03	-0.14	0.01	0.24	0.03	0.05	-0.01	0.19	0.05	0.16	-0.17	-0.12	0.13	0.08	-0.07	0.05	0.02	0.06	0.07	0.26	0.02	0.00
DK2PathsB	-0.05	0.03	0.04	-0.13	0.01	0.13	-0.06	0.04	0.32	0.19	0.06	0.07	-0.23	-0.12	0.10	0.07	-0.05	0.03	-0.04	0.07	0.08	0.25	0.02	0.03
UK2PathsB	-0.06	0.02	0.03	-0.09	0.00	0.30	0.02	0.07	-0.01	0.18	0.06	0.17	-0.27	-0.10	0.12	0.08	-0.08	0.06	0.02	0.07	0.06	0.26	0.03	-0.02
RbB1	-1.84	0.75	0.39	-1.60	-0.52	0.66	0.18	3.17	1.18	0.70	1.07	0.38	1.62	-0.52	0.05	-0.10	-0.28	-0.13	0.12	-0.25	0.91	-0.41	-0.89	-0.81
RsB1	-2.54	0.97	0.49	-1.76	-0.92	0.77	0.14	2.30	0.92	0.93	0.95	0.40	0.42	-0.55	-0.03	-0.07	-0.36	-0.28	0.10	-0.25	0.91	-0.67	-1.15	-0.01
RrB1	0.00	0.03	0.01	-0.14	0.02	0.75	0.04	0.08	0.00	0.13	0.08	0.18	0.27	-0.11	0.11	0.08	-0.13	0.08	0.01	0.03	0.06	0.28	0.03	-1.43
T2u11B1	-0.38	0.74	0.48	-1.18	-0.80	1.04	0.31	3.65	1.48	1.53	1.27	0.09	2.26	-0.39	-0.50	-0.14	-0.56	-0.13	0.23	-0.45	1.01	-0.36	-0.48	-0.66
T1u11B1	-1.00	0.72	0.49	-1.02	-0.52	1.27	0.63	0.97	0.28	1.23	0.60	0.19	1.05	-0.28	-0.34	-0.11	-0.29	-0.14	0.11	0.09	0.48	-0.13	-0.30	-1.08
T1au14B1	0.19	0.19	0.05	-0.06	0.67	1.02	0.09	0.09	-0.05	0.27	0.13	0.15	0.44	-0.03	0.49	0.18	-0.08	0.12	-0.03	0.07	0.05	0.30	0.92	-1.07
T1au13B1	-1.39	1.11	0.32	-1.10	-0.44	1.15	0.36	1.49	0.34	0.81	0.44	0.22	0.95	-0.48	-0.27	-0.07	-0.31	-0.21	0.07	-0.07	0.31	-0.25	-0.61	-1.58
T1au12B1	-2.73	1.53	0.51	-1.62	-0.77	0.91	0.58	2.70	1.10	1.45	0.89	0.36	0.51	-0.46	0.33	-0.05	-0.25	-0.09	0.24	-0.18	0.86	-0.70	-0.69	2.77
CovArcB1	-0.02	-0.01	0.04	-0.17	0.00	0.63	-0.02	0.04	0.01	0.18	0.07	0.16	-0.34	-0.13	0.13	0.09	-0.11	0.07	0.02	0.06	0.07	0.26	0.07	-0.02

Supplements

S5.2.1 Continued.

	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
CovArcB2	-0.05	-0.05	0.01	-0.18	0.02	-3.36	-0.02	-0.67	-0.03	0.11	0.00	0.07	0.14	-0.05	0.07	0.00	-0.07	0.03	0.03	0.09	0.07	0.14	0.08	-0.01
CovArcB3	-0.01	-4.83	-0.03	-3.93	-3.94	-5.34	-4.11	0.02	0.00	0.11	0.02	0.10	-0.27	-2.32	-4.02	0.05	-0.12	-3.89	-0.03	0.03	0.05	0.05	-5.92	0.00
ArcAB	-0.02	-0.04	0.01	-0.11	-0.01	0.61	-0.04	-0.02	0.02	0.15	0.00	0.17	-0.36	-0.09	0.13	0.09	-0.11	0.02	0.01	0.06	0.06	0.24	0.05	0.02
ReciprocityAB	0.00	-0.03	0.02	-0.08	-0.01	0.68	-0.03	0.03	0.04	0.14	-0.01	0.16	-0.37	-0.09	0.14	0.08	-0.11	0.02	0.01	0.06	0.05	0.24	0.04	0.02
ReciprocityAAB	0.00	-0.40	-0.04	0.08	-0.04	0.44	-0.02	0.31	0.12	-0.18	0.26	0.00	-0.30	-0.01	0.04	-0.11	-0.08	-0.23	0.04	0.31	-0.13	-1.01	0.07	-0.09
ReciprocityABB	-0.03	-0.14	0.03	-0.17	0.08	0.85	-0.03	-0.20	0.06	-0.03	-0.01	0.13	-0.35	-0.04	0.06	0.13	-0.13	-0.10	-0.10	-0.22	-0.16	0.30	0.02	-0.05
ReciprocityAABB	0.00	-0.55	-0.14	0.12	-0.12	0.46	0.01	0.57	0.20	-0.41	0.43	-0.16	-0.26	0.01	-0.08	-0.12	-0.16	-0.42	-0.01	0.52	-0.33	-0.95	0.09	-0.22
In2StarAB	-0.01	-0.01	0.02	-0.15	-0.01	1.01	-0.05	0.11	0.02	0.16	0.05	0.19	-0.37	-0.12	0.13	0.08	-0.13	0.04	0.00	0.06	0.05	0.24	0.03	0.03
Out2StarAB	-0.02	-0.04	0.00	-0.09	0.01	0.86	-0.04	-0.02	0.02	0.17	0.03	0.16	-0.36	-0.12	0.13	0.09	-0.14	0.08	0.00	0.06	0.05	0.28	0.05	0.03
Mixed2StarAB	0.01	0.01	0.02	-0.09	-0.02	0.98	-0.04	0.09	0.03	0.15	0.04	0.19	-0.41	-0.12	0.13	0.09	-0.12	0.04	0.01	0.06	0.05	0.26	0.02	0.00
Mixed2StarBA	-0.43	-0.25	0.02	-0.29	-0.01	0.59	-0.06	-0.50	-0.13	0.03	-0.75	0.17	-0.47	-0.20	-0.03	-0.03	-0.39	0.01	-0.07	-0.16	-0.23	0.23	-0.09	-0.07
TABA	0.99	0.00	-0.18	-0.01	-0.46	1.30	-0.18	-0.10	0.17	-0.06	-0.26	0.06	-0.44	-0.08	0.03	0.27	-0.22	0.30	0.13	0.03	0.16	0.69	0.43	-0.25
TABB	0.30	0.34	-0.02	-0.05	-0.10	1.15	-0.13	0.15	0.03	0.06	0.04	0.23	-0.39	-0.06	0.21	0.21	-0.07	0.08	0.00	0.11	0.12	0.57	0.48	0.09
TBBA	0.62	0.40	0.07	-0.02	0.51	1.10	0.14	-0.11	-0.06	0.12	-0.27	0.24	-0.35	-0.09	0.20	0.14	-0.18	0.59	0.06	0.14	0.06	0.51	0.84	0.85
TBAB	-0.17	0.21	-0.02	-0.21	-0.30	1.24	-0.06	-0.09	0.02	0.07	-0.19	0.17	-0.43	-0.20	0.07	0.16	-0.18	0.31	0.00	0.01	-0.03	0.26	0.40	-0.20
TAAB	0.40	0.27	0.10	0.04	-0.16	1.17	-0.11	0.46	0.13	0.16	0.10	0.29	-0.44	0.07	0.02	0.31	-0.19	0.17	0.21	0.16	0.07	0.16	0.21	-0.07
TBAA	0.71	0.04	-0.10	0.07	-0.24	1.23	-0.12	0.32	0.14	0.03	0.21	0.14	-0.45	-0.01	-0.05	0.16	-0.22	0.41	0.06	-0.03	-0.03	0.16	0.22	-0.03
CAAB	0.38	-0.03	-0.23	0.15	-0.04	1.13	-0.25	-0.78	-0.24	-0.16	-0.32	0.07	-0.45	0.02	-0.20	-0.18	-0.29	0.23	0.08	-0.25	-0.49	0.56	-0.11	-0.12
CBBA	-0.16	-0.24	-0.12	-0.24	-0.19	0.87	-0.15	-0.38	-0.19	-0.01	-0.59	0.17	-0.44	-0.17	-0.12	-0.05	-0.26	0.08	0.02	-0.10	-0.24	0.23	0.20	-0.24
IsoAB	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-0.03	-1.00	-0.05	-1.00	-1.00	-1.00	-1.00	-1.00	-0.07	-1.00	11.13	-1.00	-1.00	-1.00	-1.00
TKTABA	0.99	0.08	-0.13	-0.08	-0.45	1.07	-0.01	0.12	0.15	0.09	-0.10	0.18	-0.38	-0.06	0.29	0.44	-0.13	0.27	0.09	0.21	0.26	0.73	0.48	-0.16
CKTABA	0.44	0.13	-0.11	0.22	0.04	1.01	-0.13	-0.69	-0.34	-0.03	-0.23	0.23	-0.44	-0.02	-0.01	-0.13	-0.20	0.28	0.07	-0.18	-0.43	0.44	-0.23	0.02
DKTABA	0.01	0.02	0.02	-0.12	0.00	0.93	-0.03	0.05	0.02	0.17	0.04	0.18	-0.34	-0.13	0.13	0.09	-0.14	0.10	0.00	0.05	0.06	0.19	0.04	0.01

S5.2.1 Continued.

	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
UKTABA	-0.01	-0.02	-0.01	-0.06	0.00	0.76	-0.04	0.01	0.03	0.14	0.01	0.18	-0.36	-0.09	0.13	0.07	-0.12	0.02	0.00	0.08	0.05	0.19	0.06	0.02
TKTBAB	0.99	0.08	-0.13	-0.08	-0.45	1.07	-0.01	0.12	0.15	0.09	-0.10	0.18	-0.38	-0.06	0.29	0.44	-0.13	0.27	0.09	0.21	0.26	0.73	0.48	-0.16
CKTBAB	0.44	0.13	-0.11	0.22	0.04	1.01	-0.13	-0.69	-0.34	-0.03	-0.23	0.23	-0.44	-0.02	-0.01	-0.13	-0.20	0.28	0.07	-0.18	-0.43	0.44	-0.23	0.02
DKTBAB	0.01	0.02	0.02	-0.12	0.00	0.93	-0.03	0.05	0.02	0.17	0.04	0.18	-0.34	-0.13	0.13	0.09	-0.14	0.10	0.00	0.05	0.06	0.19	0.04	0.01
UKTBAB	-0.01	-0.02	-0.01	-0.06	0.00	0.76	-0.04	0.01	0.03	0.14	0.01	0.18	-0.36	-0.09	0.13	0.07	-0.12	0.02	0.00	0.08	0.05	0.19	0.06	0.02
mrs1	-0.46	-0.09	0.29	-0.39	-0.42	0.59	0.02	0.90	0.20	0.12	0.66	0.15	0.49	0.08	-0.19	-0.23	-0.19	-0.01	0.05	-0.01	0.40	0.37	0.07	-0.22
mrs1	-0.46	-0.09	0.29	-0.39	-0.42	0.59	0.02	0.90	0.20	0.12	0.66	0.15	0.49	0.08	-0.19	-0.23	-0.19	-0.01	0.05	-0.01	0.40	0.37	0.07	-0.22
exab1	-0.40	0.33	0.28	-0.76	0.01	1.94	-0.03	0.87	0.26	0.10	1.35	-0.05	0.07	-0.06	-0.28	0.21	-0.64	0.34	0.29	1.09	1.66	-0.59	-0.05	-0.27
exba1	1.06	-1.00	1.58	-2.34	2.65	1.35	-0.76	-0.54	2.43	2.41	1.79	1.19	2.31	-1.47	-0.22	-1.91	1.95	0.21	-0.64	-1.78	2.23	-0.45	-0.71	-2.31
mrb1	-0.29	-0.23	0.33	-1.01	-0.38	1.03	0.00	2.89	0.36	0.03	0.66	-0.05	0.43	-0.24	-0.10	-0.04	-0.40	0.05	-0.09	-0.22	1.65	0.18	-0.04	-0.32
mrbm1	0.52	0.33	0.30	-0.91	-0.07	1.42	0.03	3.42	0.76	0.01	1.49	-0.08	0.10	0.02	-0.24	0.26	-0.63	0.38	0.17	1.02	1.80	-0.51	0.11	-0.24
CovArcAB1	0.96	-0.16	0.02	-0.13	0.08	0.45	-0.02	-1.20	0.11	0.10	-0.14	0.10	-0.36	-0.34	0.19	-0.17	-0.08	-0.01	-0.26	-0.11	-0.22	0.48	0.12	0.06
CovArcAB2	1.04	0.30	-0.98	0.04	0.21	-1.38	0.14	-0.35	0.31	0.33	-0.73	0.51	-0.43	-0.99	0.34	-1.18	-0.81	-0.73	-0.39	0.44	0.15	0.32	-0.64	-0.83
CovArcAB3	-0.48	-1.74	-1.00	-2.16	-2.05	-2.22	-1.55	-0.56	-1.22	1.20	-0.25	1.92	0.03	-1.73	-0.79	-0.47	-0.75	-1.53	-0.98	-0.79	-0.87	-0.33	-0.97	-0.42

Notes. Gray cells indicate that fit was poor. Yellow cells indicate that fit was poor, but an accompanying statistic was not there (or they were too few). This suggest that the model expected more observations by chance than there actually were.

Supplements

S5.2.2 Overview of goodness of fit (*t*) statistics for each classroom network model of defending (A) and disliking (B) seperately included in this study. Classroom 1 thru 24.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
ArcA	-0.02	0.05	-0.03	0.14	0.02	0.01	0.15	-0.02	0.05	-0.02	-0.04	-0.03	-0.02	0.03	-0.04	0.01	-0.05	0.03	0.03	-0.03	-0.04	-0.06	0.05	0.04
ReciprocityA	0.03	0.04	0.09	0.03	0.05	-0.05	0.12	-0.04	-0.02	-0.01	-0.04	-0.07	-0.07	0.02	-0.07	0.03	-0.04	0.05	0.02	-0.02	-0.03	-0.02	0.07	0.04
C2InStarA	-0.41	1.04	-0.44	0.42	-0.85	-0.46	0.27	0.29	-0.02	-0.66	-0.29	-0.49	-0.15	0.61	0.53	-0.49	-0.76	0.17	-0.23	-0.23	-0.02	0.32	0.08	-0.37
C2OutStarA	0.16	0.41	1.80	0.29	0.34	0.13	0.21	0.24	0.12	-0.06	0.04	-0.08	0.02	0.20	0.15	0.27	-0.17	0.19	0.09	0.14	0.15	-0.06	0.07	-0.01
C3InStarA	-0.64	0.83	-0.71	1.27	-1.18	-0.85	0.42	0.38	-0.20	-0.84	-0.32	-0.70	-0.32	1.16	1.06	-0.73	-0.96	-0.02	-0.40	-0.47	0.04	0.13	0.31	-0.61
C3OutStarA	-0.20	0.14	1.56	-0.07	-0.08	-0.08	-0.05	0.44	-0.14	-0.11	-0.29	-0.10	0.22	-0.07	0.36	0.20	-0.24	0.00	-0.17	0.19	-0.06	-0.08	0.21	-0.31
Mixed2StarA	-0.14	0.30	-0.57	0.20	0.09	0.03	0.27	0.07	0.04	-0.05	-0.13	-0.15	-0.23	0.11	0.10	-0.10	-0.19	0.27	-0.03	-0.26	-0.11	-0.13	0.04	0.09
C030TA	-0.14	1.80	0.50	2.35	2.63	0.63	0.79	0.19	1.04	-0.09	-0.09	-0.03	-0.43	1.44	1.24	1.21	0.08	0.64	0.69	0.09	0.44	0.41	0.75	0.90
C030CA	-0.15	1.09	-0.06	0.30	0.98	0.12	-0.26	-0.66	0.15	-0.09	0.05	-0.57	-0.63	0.69	1.62	0.27	-0.15	0.51	-0.32	-0.63	-0.09	0.13	0.05	-0.65
SinkA	0.32	-0.43	2.39	1.63	1.92	1.30	2.48	-0.02	-0.98	0.08	0.00	1.03	0.47	0.07	0.34	1.32	0.78	1.04	1.01	1.15	0.87	-1.25	-0.80	-0.01
SourceA	0.33	2.15	0.88	-0.49	-0.79	0.59	0.56	3.24	-1.03	-0.59	-0.14	0.10	-0.54	-1.05	0.22	-1.39	-0.58	-0.40	-0.99	-0.14	0.29	0.39	-0.05	-1.37
IsoA	-0.24	1.76	-0.68	1.08	-0.15	-0.50	-0.68	-0.20	1.61	-0.94	-0.08	-0.79	-0.13	2.31	-0.24	-0.73	-1.13	0.76	1.18	-0.08	0.58	1.01	-1.00	0.61
KInStarA	-0.23	1.02	-0.16	0.05	-0.56	-0.24	0.18	0.21	0.04	-0.50	-0.21	-0.34	-0.07	0.29	0.15	-0.29	-0.57	0.19	-0.09	-0.11	-0.02	0.33	0.00	-0.26
KOutStarA	0.27	0.47	0.60	0.52	0.61	0.34	0.36	-0.11	0.22	-0.13	0.31	-0.06	0.02	0.44	-0.18	0.14	-0.12	0.34	0.34	0.16	0.17	-0.11	0.03	0.16
KLStarA	-0.32	-0.75	-1.24	-0.28	-0.53	-0.68	-0.61	-0.62	-0.18	0.09	-0.54	0.03	-0.13	-0.63	-0.12	0.36	0.19	-0.44	-0.43	-0.82	-0.77	-0.02	0.26	0.09
K1StarA	0.00	-0.22	-0.92	0.29	0.32	-0.09	0.17	-0.33	0.08	0.09	0.16	0.00	-0.03	-0.10	-0.08	0.16	0.03	0.06	0.14	-0.13	-0.04	-0.19	0.24	0.21
C1LStarA	-0.46	0.20	-0.46	-0.34	-0.64	-0.52	0.05	-0.11	0.05	-0.09	-0.73	-0.14	-0.40	-0.05	0.23	-0.22	-0.22	0.23	-0.41	-0.99	-0.77	0.07	0.08	-0.01
TKTriangleA	0.01	1.57	0.66	2.28	2.91	0.69	0.88	-0.12	1.16	-0.12	0.14	0.07	-0.40	1.48	1.30	1.46	0.18	0.69	1.05	0.35	0.56	0.48	0.71	1.04
CKTriangleA	-0.03	1.02	0.03	0.36	1.05	0.21	-0.22	-0.72	0.22	-0.12	0.08	-0.60	-0.60	0.68	1.53	0.66	-0.14	0.46	-0.21	-0.57	-0.03	0.11	0.18	-0.67
DKTriangleA	-0.04	1.49	0.26	1.98	2.57	0.62	0.75	-0.35	0.97	0.00	-0.16	0.15	-0.48	1.05	0.98	1.05	0.12	0.85	0.91	-0.04	0.56	0.40	0.30	1.04
UKTriangleA	-0.81	1.34	-0.36	2.35	1.03	0.05	0.90	0.26	0.94	-0.02	-0.35	-0.18	-0.28	1.52	1.72	0.78	0.20	0.47	0.79	-0.15	-0.15	0.65	0.90	1.05
TK2PathsA	0.00	0.05	-0.60	0.12	0.03	-0.04	0.15	0.00	0.03	-0.01	-0.08	-0.04	-0.06	0.05	-0.02	0.02	-0.04	0.05	0.03	-0.05	-0.04	-0.02	0.05	0.03

S5.2.2 Continued.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
DK2PathsA	0.04	0.07	1.46	0.16	0.01	0.11	0.12	0.05	0.06	0.02	0.01	-0.02	-0.01	-0.02	-0.05	-0.03	-0.02	-0.03	0.02	0.02	-0.04	-0.06	-0.01	0.03
UK2PathsA	-0.79	0.60	-1.19	0.20	-2.08	-1.15	0.07	0.04	-0.30	-0.62	-0.73	-0.59	-0.44	0.22	0.25	-1.12	-0.80	0.07	-0.60	-0.93	-0.33	0.43	-0.24	-0.36
RbA1	-0.11	0.27	0.95	-0.29	1.27	0.02	0.37	0.63	0.50	-0.75	2.33	0.17	0.78	1.03	0.24	0.44	-0.20	-0.24	-0.74	-0.41	-0.58	-0.01	0.94	0.56
RsA1	-0.18	0.41	1.02	-0.59	-1.25	0.07	0.53	1.04	0.94	-1.31	2.50	0.31	1.52	1.59	0.52	0.81	-0.38	-0.48	-1.35	-0.66	-0.85	0.01	1.08	0.19
RrA1	-0.06	0.02	-0.02	0.10	0.07	0.01	0.17	-0.01	0.01	-0.01	0.02	0.00	-0.04	-0.02	-0.08	-0.01	-0.02	0.03	0.00	-0.06	-0.02	-0.05	0.04	0.08
T2u11A1	-1.22	-0.50	-0.27	-0.07	-0.83	-0.94	-0.80	0.00	0.37	-0.54	3.18	0.07	0.17	0.15	-0.63	0.90	0.27	0.24	-1.00	0.36	-0.82	0.04	0.59	0.16
T1u11A1	-1.22	-0.27	-0.68	0.60	-1.24	-0.94	0.01	-0.19	0.32	-0.83	1.33	0.02	0.10	-0.04	-0.12	1.43	0.27	0.21	-0.68	0.63	-0.12	0.02	0.22	0.14
T1au14A1	-0.70	0.58	-0.35	-0.91	-0.51	-0.17	0.01	0.10	0.22	-0.48	-0.31	-0.44	-0.52	-0.24	0.26	-0.62	-0.76	-0.11	-0.09	-0.32	0.44	0.25	0.22	-0.71
T1au13A1	0.26	0.20	-0.70	-0.05	-0.91	-0.51	0.08	0.78	0.25	-0.30	2.69	0.18	1.38	0.56	0.08	0.34	-0.49	0.06	-0.85	-0.26	-0.83	0.04	0.45	-0.44
T1au12A1	0.14	0.59	1.19	-0.18	-0.62	0.13	0.25	1.88	1.27	-1.13	2.15	0.45	2.60	1.54	0.72	0.47	-0.82	-0.14	-0.54	-0.75	-1.09	0.02	1.28	0.39
CovArcA1	-0.01	0.05	-0.03	0.14	4.10	-0.03	0.12	-0.06	0.03	0.02	-0.06	-0.04	-0.04	0.04	-0.04	0.01	-0.04	0.03	0.02	-0.04	-0.04	-0.05	0.05	0.57
CovArcA2	-0.69	0.04	-1.11	0.08	-0.99	-0.66	-1.78	-0.02	-0.73	0.03	0.31	-0.03	-1.78	-0.03	-1.85	-1.74	-0.05	0.00	-1.57	-2.55	-0.99	-1.62	-2.27	0.04
CovArcA3	0.00	0.06	0.36	0.12	0.03	0.01	0.14	-0.04	0.04	0.03	-0.04	-0.03	0.00	0.01	-0.04	0.02	-0.03	0.01	0.03	0.02	-0.04	-0.06	0.05	0.04
ArcB	-0.02	0.01	-0.30	-0.17	0.07	-0.02	-0.16	-0.06	-0.03	0.00	-0.01	0.04	0.05	0.02	0.06	0.05	0.02	0.00	-0.02	0.00	0.05	-0.01	0.01	-0.13
ReciprocityB	-0.04	-0.03	0.77	-0.14	-0.37	-0.01	-0.10	-0.07	0.00	0.01	0.01	0.03	0.64	0.87	0.08	0.02	1.69	0.01	-0.07	-0.02	0.03	-0.06	0.02	-0.13
C2InStarB	1.45	1.02	0.46	0.09	0.46	0.14	-0.07	0.19	0.10	0.07	-0.06	0.68	0.09	1.24	1.76	1.79	0.30	0.42	0.31	0.02	0.05	-0.02	0.10	0.17
C2OutStarB	2.01	0.31	0.29	0.00	0.57	0.15	-0.01	0.24	0.09	0.09	-0.04	0.42	0.19	0.70	1.65	1.61	0.46	2.48	0.19	-0.04	0.12	0.04	0.08	0.18
C3InStarB	1.27	1.33	0.99	0.27	0.46	0.42	-0.24	0.05	0.20	-0.15	-0.15	0.76	-0.13	2.07	2.63	2.86	-0.09	0.73	-0.19	-0.16	-0.05	-0.18	-0.12	0.09
C3OutStarB	1.74	-0.22	0.41	-0.12	0.78	0.37	0.01	0.24	0.04	-0.06	-0.11	0.34	0.13	0.87	1.78	2.22	0.33	4.04	0.10	-0.07	-0.14	-0.05	0.01	0.13
Mixed2StarB	0.49	0.20	0.12	-0.08	-0.13	-0.07	-0.18	-0.22	0.03	-0.04	-0.02	0.22	0.02	0.27	1.23	1.21	0.41	0.18	-0.20	0.00	0.11	-0.10	0.03	0.04
C030TB	2.55	-0.56	-0.14	0.05	0.57	-0.49	-0.63	-0.44	-0.10	-0.27	-0.30	0.36	-0.24	0.37	2.14	1.01	1.20	1.11	0.34	0.66	-0.28	-0.84	0.37	-0.30
C030CB	0.21	-0.62	-0.15	-0.61	-0.07	-0.60	-0.16	0.55	-0.78	-0.47	-0.12	0.57	-0.05	-0.16	0.57	0.48	1.60	0.48	-0.13	1.35	-0.28	-0.69	-0.21	-0.47
SinkB	0.91	0.97	3.03	0.00	1.37	0.06	0.10	0.05	0.00	-0.03	-0.01	2.54	-0.01	-0.01	1.35	1.74	0.02	0.04	-0.60	-0.06	-0.02	0.02	0.00	0.14

Supplements

S5.2.2 Continued.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
SourceB	2.06	0.56	2.03	-0.01	0.49	0.04	0.00	0.01	-0.01	-0.05	-0.05	0.01	-0.07	0.03	4.30	3.73	3.27	-0.37	0.04	0.05	0.00	-0.02	-0.03	-0.40
IsoB	4.95	1.87	-0.19	0.31	-0.09	0.03	0.16	-0.23	0.04	0.05	0.00	-0.06	-0.12	-0.11	6.02	-0.16	-0.15	-0.19	-0.11	-0.01	-0.02	-0.01	0.01	3.41
KInStarB	0.73	0.85	-0.11	-0.08	0.30	-0.01	-0.08	0.08	0.03	0.11	0.00	0.10	0.14	0.26	0.81	0.41	0.41	0.11	0.16	0.09	0.07	0.05	0.12	-0.01
KOutStarB	0.68	0.86	-0.01	-0.06	0.44	0.01	-0.07	0.00	0.06	0.09	-0.02	0.16	0.10	0.18	0.71	0.32	0.17	0.49	-0.01	-0.03	0.14	0.04	0.05	0.00
KLStarB	-3.07	-1.32	-2.17	-0.23	-0.72	-0.21	-0.54	-0.56	-0.32	-0.34	-0.12	-0.40	-0.19	-1.52	-3.03	-3.61	-0.65	-1.38	-0.40	0.17	-0.06	-0.12	-0.15	-0.31
K1StarB	-0.81	0.34	-0.53	-0.17	-0.12	-0.17	-0.32	-0.37	-0.12	-0.19	-0.09	0.03	-0.04	-0.26	-0.29	-0.80	0.06	-0.17	-0.34	0.13	0.15	-0.05	-0.07	-0.12
C1LStarB	-1.00	-1.31	-0.70	-0.04	-0.68	-0.24	-0.51	-0.38	-0.34	-0.09	0.00	-0.04	-0.10	-0.56	-0.04	-0.37	0.30	-0.81	-0.02	0.14	-0.01	0.06	-0.13	0.06
TKTriangleB	1.71	-0.54	-0.12	0.00	0.77	-0.46	-0.69	-0.27	-0.05	-0.22	-0.29	0.00	-0.24	0.13	1.07	0.50	0.84	0.78	0.14	0.66	-0.25	-0.85	0.49	-0.32
CKTriangleB	-0.06	-0.63	-0.37	-0.60	-0.07	-0.56	-0.16	0.52	-0.82	-0.45	-0.13	0.33	0.00	-0.28	0.20	-0.18	1.19	0.25	-0.15	1.33	-0.22	-0.71	-0.14	-0.54
DKTriangleB	1.29	-0.67	-0.73	0.06	0.86	-0.44	-0.54	-0.44	-0.28	-0.26	-0.28	0.14	-0.22	0.24	0.84	-0.02	0.89	1.14	0.16	1.04	-0.33	-0.84	0.32	-0.46
UKTriangleB	0.81	-0.48	-0.17	-0.07	-0.15	-0.60	-0.64	-0.51	-0.02	-0.33	-0.28	-0.08	-0.21	-0.40	1.05	0.14	0.82	0.16	-0.07	0.71	-0.12	-0.84	0.28	-0.32
TK2PathsB	-0.04	0.01	-0.27	-0.13	0.01	-0.01	-0.14	-0.06	-0.04	0.03	-0.02	0.03	0.04	-0.01	0.06	0.06	-0.03	0.00	-0.39	-0.01	0.04	-0.05	0.02	-0.13
DK2PathsB	-0.02	0.01	-0.41	-0.12	0.05	-0.01	-0.12	-0.04	-0.01	0.03	-0.02	-0.01	0.06	-0.04	0.04	0.05	0.04	2.74	-0.05	-0.04	0.06	0.00	0.01	-0.07
UK2PathsB	0.05	-0.02	-0.21	-0.12	0.06	0.00	-0.15	-0.06	-0.04	0.01	-0.04	0.04	0.00	0.05	0.05	0.07	0.01	-0.01	-0.06	0.02	0.04	-0.03	0.02	-0.12
RbB1	-2.58	-0.55	0.73	-1.09	0.32	-0.56	-0.15	-1.90	-0.37	0.10	0.22	-0.95	-1.86	-0.16	0.98	-0.26	0.88	-0.65	-0.42	0.00	0.34	-0.30	0.23	0.26
RsB1	-3.05	-0.88	0.38	-1.06	0.30	-0.29	-0.19	-1.43	-0.31	0.07	0.09	-0.89	-1.73	-0.25	1.04	-0.42	0.93	-0.86	-0.63	-0.01	0.41	-0.51	0.27	0.29
RrB1	0.05	-0.01	-0.22	-0.16	0.06	-0.04	-0.14	-0.03	-0.03	0.01	0.01	0.02	0.02	0.06	0.07	0.05	0.00	-0.01	0.01	0.00	0.05	-0.04	0.00	-0.10
T2u11B1	-1.04	-0.75	0.42	-0.77	-0.16	-0.56	-0.36	-0.62	-0.46	0.66	-0.52	0.01	-0.32	0.97	-0.25	-0.04	1.09	0.56	1.03	0.11	0.92	-0.43	-0.14	0.73
T1u11B1	-0.47	-1.08	0.88	-0.50	-0.31	-0.01	-0.46	-0.17	-0.67	-0.31	0.05	-0.22	0.07	0.96	-0.04	0.12	1.61	-0.33	0.20	0.06	0.13	-0.63	-0.01	-0.03
T1au14B1	-0.06	0.75	0.71	0.04	-0.60	-0.38	-0.21	-0.30	-0.18	0.86	-0.04	0.27	0.00	1.30	1.15	1.14	-0.05	0.64	-0.09	0.04	0.16	0.13	0.20	0.14
T1au13B1	-1.65	-1.17	0.77	-0.52	0.94	-0.13	-0.73	-0.92	-1.03	0.01	-0.30	-0.20	-0.89	0.32	1.40	1.06	0.11	-0.20	0.14	-0.06	0.29	-0.30	-0.28	0.09
T1au12B1	-1.59	1.48	0.66	-0.88	0.73	-0.24	-0.02	-1.23	-0.16	0.41	-0.04	-0.79	-1.49	0.08	2.03	0.77	0.66	0.37	-0.52	0.00	0.91	-0.53	0.29	0.85
CovArcB1	-0.09	-0.04	-0.11	-0.14	0.03	0.02	-0.15	-0.02	-0.02	0.00	0.00	0.05	0.07	0.01	0.02	0.05	0.00	-0.01	0.00	0.01	0.04	0.03	0.01	-0.14

S5.2.2 Continued.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
CovArcB2	-0.02	0.01	0.07	-0.21	-0.59	-0.04	-0.17	-0.10	-0.01	0.11	-0.01	-0.04	0.03	0.05	0.02	0.03	0.05	-0.01	0.02	-0.01	0.07	0.01	0.03	-0.02
CovArcB3	-4.56	0.02	0.00	-3.39	0.02	-2.61	-2.78	-0.05	0.01	-2.14	-0.01	-4.23	-0.01	0.02	-0.03	0.01	0.01	0.01	-4.66	-0.05	-1.74	0.08	0.00	-0.09
ArcAB	-0.02	-0.57	-0.47	-1.56	0.02	-1.92	-2.06	0.03	0.00	0.04	-0.79	-1.76	0.07	-1.41	-0.79	-1.98	-1.21	-0.07	0.03	-1.58	-1.61	-0.34	-1.26	-0.30
ReciprocityAB	-1.81	0.08	0.17	-0.06	0.02	-0.05	-0.10	-0.04	0.02	0.04	0.04	-0.02	0.11	-1.95	0.08	0.02	-1.29	0.01	0.04	0.02	-1.40	-1.54	-0.01	-0.93
ReciprocityAAB	-0.55	-0.32	-1.11	-0.59	0.74	-0.43	-0.83	-0.64	0.74	-0.60	-0.26	-0.41	-0.46	-0.61	-0.39	-0.58	-0.44	0.87	-0.47	0.90	-0.76	-0.62	-0.37	-0.35
ReciprocityABB	-0.42	-0.13	0.90	-0.75	-0.12	-0.67	-0.64	-0.42	-0.22	-0.58	-0.35	-0.50	1.08	-0.54	-0.29	-0.75	-0.54	0.45	0.69	-0.77	-0.85	-0.34	-0.87	-0.64
ReciprocityAABB	-0.07	-1.00	-0.54	-0.16	-1.00	-0.11	-0.16	-0.08	-0.06	-0.37	-0.06	-0.05	-0.06	-0.11	-0.03	-0.09	-0.09	-0.14	-0.08	-0.16	-0.38	-0.12	-0.39	-0.11
In2StarAB	-0.09	0.05	-0.26	-0.18	0.02	-0.03	-0.13	-0.02	-0.03	0.01	-0.01	-0.03	0.02	0.01	0.00	0.02	-0.02	0.00	0.01	-0.01	0.04	-0.04	0.01	-0.07
Out2StarAB	-0.05	0.03	0.53	-0.16	0.04	0.01	-0.14	-0.05	-0.04	0.00	0.03	-0.01	0.04	0.09	-0.01	0.01	-0.05	0.00	0.03	0.01	0.04	0.00	0.01	-0.10
Mixed2StarAB	0.00	0.04	-0.02	-0.16	0.05	-0.02	-0.15	-0.08	-0.03	0.01	-0.01	-0.04	0.02	0.04	0.02	0.05	-0.04	0.00	0.03	-0.02	0.02	-0.07	0.03	-0.13
Mixed2StarBA	-0.48	-0.61	2.04	0.72	0.70	-0.59	0.74	0.14	0.05	0.55	0.00	0.52	0.88	0.92	0.98	-0.17	0.44	0.64	0.75	0.21	-0.17	0.26	0.10	0.84
TABA	1.17	0.17	-0.14	-1.99	0.13	-1.16	0.04	0.12	0.22	-0.90	0.46	-0.94	0.61	-1.41	-0.74	-0.62	1.56	-1.02	-0.52	0.23	-0.59	0.11	0.13	-1.21
TABB	2.20	0.15	0.55	0.57	0.21	0.51	-0.05	0.63	0.55	-0.02	0.53	0.50	-0.01	1.62	1.64	2.86	-0.59	1.08	0.60	-0.30	0.65	-0.06	-0.17	-0.35
TBBA	1.37	0.78	3.59	1.45	2.52	0.39	0.78	0.90	0.85	1.60	0.73	1.07	0.34	2.45	3.29	3.90	0.94	2.43	0.69	0.18	0.72	0.66	0.31	1.98
TBAB	-0.59	-0.57	0.43	0.92	1.57	0.22	0.36	-0.03	1.32	0.10	0.57	1.00	-0.29	1.06	1.73	2.58	-0.12	0.69	0.35	-0.36	0.59	1.26	-0.06	0.86
TAAB	-0.05	0.44	-0.49	-0.01	0.16	-0.20	-0.11	-0.18	0.03	-0.07	-0.12	-0.03	-0.21	0.12	-0.10	0.03	-0.06	-0.29	-0.07	-0.21	-0.05	0.00	-0.05	-1.56
TBAA	-0.10	-0.06	0.65	0.03	1.43	-0.24	0.31	1.10	0.10	0.03	-0.30	-0.22	0.99	0.10	0.00	-0.16	0.04	0.31	0.12	0.15	-0.27	-0.14	0.05	-0.07
CAAB	0.67	-0.98	0.13	-0.06	0.95	0.49	1.23	-0.50	-0.20	1.07	-0.15	-0.40	1.06	-0.12	0.38	-0.17	0.35	-0.59	0.80	0.73	0.59	-0.74	0.75	-0.35
CBBA	-1.07	0.12	2.46	0.58	-0.14	-0.45	-0.06	-0.41	0.83	0.05	0.69	0.15	0.90	1.33	1.47	2.10	0.94	0.53	0.38	-0.38	0.20	0.58	-0.04	0.97
IsoAB	-0.03	-0.52	-1.00	-0.07	0.82	-0.29	-0.03	-1.00	-0.05	-0.52	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-0.03	-1.00	-1.00	-0.03	-0.03	2.98	-1.00	-0.03
TKTABA	1.46	0.14	-0.34	-2.04	0.12	-1.14	0.03	0.08	0.26	-0.91	0.41	-0.94	0.74	-1.47	-0.74	-0.49	1.81	-1.13	-0.42	0.43	-0.46	0.21	0.31	-1.22
CKTABA	0.89	-0.96	-0.27	-0.09	0.88	0.59	0.60	-0.22	-0.06	0.93	-0.03	-0.47	1.11	-0.18	0.49	-0.17	0.44	-0.79	0.92	1.01	0.57	-0.71	0.58	-0.33
DKTABA	-0.03	0.12	-0.32	-0.05	0.02	0.01	-0.12	0.02	0.10	0.00	0.06	0.00	0.04	0.00	0.00	-0.01	-0.03	-0.03	0.04	0.03	-0.01	-0.05	0.01	-1.58

S5.2.2 Continued.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
UKTABA	-0.08	0.01	-0.40	-0.11	-0.01	0.00	-0.07	-0.03	0.04	-0.01	0.02	0.05	0.07	0.01	-0.02	-0.01	-0.04	0.00	0.02	-0.03	0.03	0.01	0.04	-0.03
TKTBAB	1.46	0.14	-0.34	-2.04	0.12	-1.14	0.03	0.08	0.26	-0.91	0.41	-0.94	0.74	-1.47	-0.74	-0.49	1.81	-1.13	-0.42	0.43	-0.46	0.21	0.31	-1.22
CKTBAB	0.89	-0.96	-0.27	-0.09	0.88	0.59	0.60	-0.22	-0.06	0.93	-0.03	-0.47	1.11	-0.18	0.49	-0.17	0.44	-0.79	0.92	1.01	0.57	-0.71	0.58	-0.33
DKTBAB	-0.03	0.12	-0.32	-0.05	0.02	0.01	-0.12	0.02	0.10	0.00	0.06	0.00	0.04	0.00	0.00	-0.01	-0.03	-0.03	0.04	0.03	-0.01	-0.05	0.01	-1.58
UKTBAB	-0.08	0.01	-0.40	-0.11	-0.01	0.00	-0.07	-0.03	0.04	-0.01	0.02	0.05	0.07	0.01	-0.02	-0.01	-0.04	0.00	0.02	-0.03	0.03	0.01	0.04	-0.03
mrs1	2.69	-0.47	-1.29	-0.83	-0.55	-0.88	-1.74	-0.28	-0.76	1.43	-0.52	-1.09	0.03	-1.31	-0.65	-1.80	-0.96	0.51	-0.56	-1.41	-1.49	-0.75	-0.98	0.07
mrs1	2.69	-0.47	-1.29	-0.83	-0.55	-0.88	-1.74	-0.28	-0.76	1.43	-0.52	-1.09	0.03	-1.31	-0.65	-1.80	-0.96	0.51	-0.56	-1.41	-1.49	-0.75	-0.98	0.07
exab1	-1.69	0.25	2.49	-0.61	0.14	-0.72	0.57	0.19	0.56	-0.77	1.40	-0.63	-1.01	-1.62	1.04	-0.87	-1.06	-0.67	0.06	0.13	-1.29	-0.97	0.35	-0.35
exba1	0.70	0.35	2.42	0.27	0.52	2.56	1.42	0.89	0.41	0.60	-0.87	0.71	1.18	-0.67	-0.79	0.59	-1.81	-0.58	-1.89	-0.06	1.19	0.92	-1.29	-1.49
mrb1	3.21	-0.37	-0.13	-0.73	-0.51	-0.88	-1.50	-0.89	-0.73	-0.61	-0.35	-1.03	-0.74	-1.04	-0.60	-1.53	-0.93	0.70	-0.48	-1.40	-1.44	-0.74	-1.25	0.51
mrbm1	-1.67	-0.50	1.84	-0.39	0.69	-0.70	0.14	-1.34	-0.73	-0.62	1.00	-0.58	-1.00	-1.49	0.52	-0.79	-1.01	-0.60	-0.06	0.19	-1.23	-0.96	0.59	-0.11
CovArcAB1	0.03	-0.47	-1.38	-1.39	1.81	-2.00	-1.86	-0.27	0.08	-0.88	-0.68	-1.69	-0.42	-1.15	-0.72	-1.66	-1.19	0.14	0.04	-1.57	-1.54	-0.31	-1.44	0.15
CovArcAB2	-0.26	-0.20	-0.87	-0.81	-0.12	-0.12	-1.07	-0.48	-0.54	0.46	-0.51	-0.40	-0.68	-0.66	-0.35	-0.79	-0.57	-0.86	-0.62	-1.22	-0.82	-0.69	-0.99	-0.36
CovArcAB3	-1.12	-0.41	-0.53	-1.85	0.89	-1.86	-1.81	-0.51	0.33	-0.79	-0.79	-1.55	-0.43	-0.68	-0.65	-0.79	-0.68	-0.39	-1.45	-0.41	-1.57	-0.66	-1.10	-0.83

Notes. Gray cells indicate that fit was poor. Yellow cells indicate that fit was poor, but an accompanying statistic was not there (or they were too few). This suggest that the model expected more observations by chance than there actually were. Orange cells indicate that the observed statistic was equal to the total number of ties in the network, and could therefore not be included. This happened sometimes for CovArcA1, referring to same-sex.

S5.2.2 Overview of goodness of fit (*t*) statistics for each classroom network model of defending (A) and disliking (B) seperately included in this study. Classroom 25 thru 48.

	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
ArcA	0.04	0.04	0.04	0.00	0.01	0.12	-0.03	-0.03	0.03	0.01	-0.04	0.00	0.01	0.05	-0.05	0.03	0.03	0.02	0.01	0.02	0.00	0.00	-0.01	-0.05
ReciprocityA	-0.04	0.04	0.04	-0.05	-0.02	0.10	-0.04	-0.02	0.04	0.04	-0.04	0.04	0.05	0.06	-0.08	0.02	0.01	0.01	0.03	0.01	0.02	-0.72	0.02	-0.02
C2InStarA	-0.06	0.76	0.28	-0.09	-0.33	0.35	0.35	-0.12	0.61	-0.11	0.19	0.04	-0.08	0.60	-0.15	0.16	0.49	0.16	0.74	-0.20	-0.06	-0.45	-0.33	0.03
C2OutStarA	0.58	0.09	0.36	0.26	-0.05	0.27	0.74	0.31	0.08	0.33	0.08	0.58	-0.01	0.91	-0.06	0.74	0.04	0.24	0.43	0.04	0.07	-0.06	0.01	0.02
C3InStarA	-0.17	1.47	0.19	0.16	-0.68	0.25	0.50	-0.36	1.49	-0.24	-0.02	0.03	0.02	1.09	-0.10	0.00	1.13	0.24	1.62	-0.36	-0.28	-0.43	-0.54	-0.04
C3OutStarA	0.78	0.01	0.05	0.59	-0.26	0.12	0.85	0.23	0.04	-0.11	-0.09	0.29	-0.20	0.78	-0.03	0.94	-0.12	0.25	0.52	-0.03	0.00	-0.19	-0.09	-0.06
Mixed2StarA	0.42	0.04	-0.05	-0.02	-0.12	0.26	0.29	-0.12	0.30	-0.08	-0.14	-0.14	-0.08	0.43	-0.17	0.18	-0.10	0.02	0.12	-0.15	0.06	0.06	-0.01	-0.13
C030TA	2.58	1.29	0.52	0.50	0.00	0.95	2.10	0.35	1.21	1.02	0.72	0.44	0.43	1.46	0.33	0.99	1.10	1.85	0.93	-0.08	0.73	0.90	1.00	0.23
C030CA	1.91	0.08	-0.35	0.42	-0.55	1.03	0.11	0.01	-1.14	0.70	-0.67	-0.24	-0.85	0.95	0.05	-0.69	-0.27	1.10	0.54	-0.74	-0.45	-0.19	0.40	-0.36
SinkA	1.12	0.28	1.44	-0.47	0.12	0.87	0.20	0.87	-1.34	2.15	-0.99	0.52	1.32	2.24	-0.06	-1.45	-0.13	0.65	0.62	0.35	0.91	0.97	1.00	-0.51
SourceA	-0.12	0.75	1.05	-1.08	1.15	1.65	-0.62	0.80	-1.82	-1.04	-0.69	2.52	0.49	-1.00	0.13	0.87	0.03	0.19	-1.00	-1.21	1.50	0.26	-0.01	-0.19
IsoA	-1.36	-0.76	-0.10	-0.95	0.19	-0.17	3.59	-0.13	1.41	0.97	1.24	-0.31	-0.85	-1.00	-0.70	0.89	-0.66	0.24	-1.00	0.15	-1.12	-0.96	-0.38	0.04
KInStarA	-0.05	0.35	0.27	-0.25	0.01	0.35	0.14	0.00	0.10	-0.03	0.25	0.05	-0.10	0.16	-0.14	0.24	0.05	0.13	0.14	-0.10	0.03	-0.43	-0.14	0.02
KOutStarA	0.29	0.02	0.34	-0.23	0.14	0.26	0.25	0.14	0.02	0.65	0.17	0.22	0.13	0.54	-0.07	0.15	-0.01	0.24	0.13	0.03	0.07	-0.02	0.08	0.00
KLStarA	0.20	0.03	-1.20	0.61	-0.33	-0.88	-0.45	-1.17	0.96	-0.67	-0.14	-0.77	-0.10	-2.46	-0.25	-1.25	-0.24	-0.36	-0.83	0.47	-0.56	0.09	-0.11	-0.21
K1StarA	0.44	0.07	-0.10	0.03	0.23	-0.11	0.12	-0.39	0.68	-0.09	-0.13	0.08	-0.08	-0.62	-0.12	-0.31	0.08	-0.15	-0.05	0.12	-0.02	0.11	0.14	-0.20
C1LStarA	0.20	0.40	-1.17	-0.01	-0.42	-0.24	0.23	-0.81	0.33	-0.48	-0.11	-0.57	-0.06	-0.75	-0.33	-0.73	-0.46	-0.04	-0.16	-0.01	-0.30	0.08	-0.17	-0.04
TKTriangleA	2.49	1.38	0.69	0.42	0.10	0.82	1.48	0.62	0.86	1.40	0.93	0.56	0.63	1.08	0.49	1.19	1.23	1.83	0.50	0.04	0.99	0.98	1.18	0.21
CKTriangleA	2.16	0.12	-0.31	0.52	-0.54	0.86	-0.01	0.07	-1.20	0.82	-0.75	-0.10	-0.85	0.29	0.15	-0.80	-0.16	1.24	0.50	-0.64	-0.38	-0.20	0.44	-0.41
DKTriangleA	2.26	0.90	0.36	0.56	0.35	0.80	1.36	-0.05	1.11	0.69	0.69	0.32	0.23	0.50	0.50	0.38	1.25	1.84	0.32	-0.06	0.72	1.02	0.98	0.10
UKTriangleA	1.72	1.56	-0.24	-0.16	-0.20	0.39	0.96	-0.38	1.15	0.95	0.71	0.18	0.62	0.68	0.46	0.28	1.08	1.43	0.66	0.13	0.93	0.69	1.06	0.13
TK2PathsA	0.02	0.04	0.05	-0.02	-0.01	0.12	-0.01	-0.03	0.08	0.02	-0.06	0.02	0.03	0.06	-0.04	0.04	-0.01	-0.01	0.02	0.02	0.02	-0.01	-0.04	-0.03

Supplements

S5.2.2 Continued.

	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
DK2PathsA	0.03	0.02	0.04	0.01	-0.01	0.12	0.02	-0.04	0.03	0.03	-0.02	-0.09	-0.07	0.04	-0.01	0.02	0.02	0.00	0.02	0.00	0.03	-0.01	-0.02	-0.05
UK2PathsA	-1.06	0.56	-0.31	-0.22	-0.30	0.03	-1.09	-1.53	0.65	-0.79	-0.06	-0.67	-0.26	-0.51	-0.20	-1.11	0.61	-0.14	0.50	-0.42	-0.26	-0.44	-0.67	-0.12
RbA1	1.59	0.10	0.72	0.33	0.09	0.54	-0.09	-0.18	0.10	0.15	-0.04	0.01	-0.04	1.30	-0.09	1.21	-0.68	0.08	-0.12	0.42	1.02	0.24	0.00	-0.23
RsA1	-0.84	0.15	1.13	0.64	0.12	0.72	-0.19	-0.16	0.14	0.31	-0.03	-0.05	-0.09	1.96	-0.11	1.78	-1.23	0.16	-0.16	0.70	1.53	0.47	0.02	-0.42
RrA1	0.04	0.02	0.01	-0.01	0.03	0.11	0.02	-0.03	-0.05	-0.02	-0.05	0.05	-0.02	0.04	-0.06	0.07	0.03	0.01	0.00	0.02	-0.03	-0.03	-0.02	-0.03
T2u11A1	0.93	-0.46	0.58	-0.22	-0.04	1.21	-0.05	-0.83	1.50	0.08	1.03	-0.03	-0.34	1.45	-0.40	0.65	0.14	0.64	0.84	0.55	1.59	-0.21	-0.10	-0.16
T1u11A1	0.30	-0.50	1.31	-0.40	-0.04	1.13	-0.05	-0.91	0.47	0.08	1.03	-0.06	-0.34	1.05	-0.44	0.38	-0.10	0.63	1.59	0.50	1.25	-0.24	-0.08	-0.17
T1au14A1	-0.27	-0.36	1.30	-0.35	-0.46	0.52	-0.39	0.20	-0.31	-0.24	-0.16	0.08	-0.79	0.87	0.04	0.22	0.64	-0.06	0.53	-0.11	-0.64	0.00	-0.33	-0.02
T1au13A1	0.40	-0.23	-0.12	0.08	-0.11	1.09	0.18	-0.78	1.40	0.96	0.56	-0.20	-0.20	1.38	0.02	1.85	-0.42	0.28	0.63	0.59	1.09	-0.16	-0.15	-0.27
T1au12A1	-0.71	0.30	1.35	-0.23	0.43	0.41	0.54	-0.39	0.09	1.81	0.74	0.03	0.96	2.28	-0.05	1.98	-1.13	0.20	-0.21	1.74	1.84	0.10	0.24	-0.27
CovArcA1	2.62	0.04	0.05	-0.03	0.04	0.12	-0.04	-0.02	0.04	0.01	-0.04	0.02	0.02	0.03	-0.06	0.00	0.04	0.01	-0.02	0.04	0.00	0.01	0.00	-0.05
CovArcA2	-0.05	0.00	-1.46	-0.05	-0.04	-0.56	-0.03	-2.40	-0.03	-0.01	-1.18	-0.02	-0.36	-1.76	0.01	-1.72	0.02	-1.04	0.00	0.05	0.06	-0.01	-1.47	0.01
CovArcA3	0.04	0.08	0.01	0.00	0.03	0.12	-0.03	-0.02	0.05	0.03	-0.02	-0.02	0.02	0.03	-0.03	0.03	0.02	0.02	0.02	0.02	0.03	0.01	-0.02	-0.09
ArcB	-0.06	0.09	-0.06	0.12	0.02	-0.12	0.02	0.07	-0.09	-0.02	0.03	0.01	-0.02	0.01	-0.10	0.00	0.00	0.01	-0.08	0.02	0.01	-0.07	0.01	0.01
ReciprocityB	-0.76	0.02	-0.05	0.10	0.06	-0.03	0.04	0.05	-0.11	-0.03	0.03	0.01	-0.01	0.04	-0.10	0.00	0.01	-0.01	-0.03	0.02	0.01	-0.07	0.00	0.03
C2InStarB	-0.09	0.07	-0.06	0.11	1.07	0.01	-0.03	0.07	-0.06	0.60	0.24	0.08	0.43	0.72	0.32	0.48	0.51	0.04	0.06	0.54	0.42	0.40	0.15	0.52
C2OutStarB	-0.06	0.07	-0.08	0.02	0.79	0.01	-0.12	0.04	-0.04	0.93	0.13	0.07	1.18	0.75	0.31	0.63	0.67	0.02	0.03	0.51	0.59	0.39	0.18	0.41
C3InStarB	-0.17	-0.18	-0.09	-0.15	0.43	0.01	-0.09	-0.07	-0.20	0.80	-0.03	0.02	0.32	0.79	-0.16	0.55	0.15	-0.14	-0.13	0.67	0.21	-0.04	0.17	-0.01
C3OutStarB	-0.04	0.01	-0.11	-0.05	0.46	0.32	-0.25	-0.14	-0.01	0.31	0.04	0.05	0.27	1.00	0.70	0.41	1.02	-0.16	0.06	1.09	0.98	0.89	0.30	0.52
Mixed2StarB	-0.18	0.03	-0.10	0.15	0.29	-0.09	0.01	0.02	-0.11	0.31	0.20	0.12	0.32	0.52	0.07	0.30	0.15	0.04	-0.01	0.01	-0.03	-0.57	0.05	0.28
C030TB	-0.52	-0.20	0.16	-0.10	1.61	-0.07	-0.05	0.13	-0.04	1.33	0.55	0.10	0.65	0.66	0.54	1.27	1.17	-0.50	-0.20	-0.45	0.63	-0.58	-0.11	0.90
C030CB	-0.53	-0.08	-0.20	0.54	0.68	-0.57	-0.16	1.02	-0.18	0.85	0.87	0.38	-0.34	0.07	0.13	1.87	0.60	-0.29	-0.23	-0.22	-0.56	-1.83	-0.09	0.25
SinkB	0.08	-0.08	-0.02	-0.13	1.02	-0.06	-0.07	-0.02	0.08	0.03	-0.03	-0.20	-0.01	1.31	0.07	0.01	0.04	-0.04	0.00	-0.06	0.01	-1.18	0.02	0.04

S5.2.2 Continued.

	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
SourceB	0.02	0.02	0.04	0.03	0.05	-0.08	0.02	0.01	0.04	-0.03	0.02	-0.01	2.28	0.00	0.06	0.71	-0.02	0.01	0.08	0.00	-0.04	0.08	0.00	-0.04
IsoB	0.01	-0.05	0.06	-0.06	9.30	0.17	0.01	-0.06	-0.56	-0.06	-0.05	1.10	-0.09	18.22	-0.05	-0.19	0.02	-0.01	0.04	-1.00	-0.08	-0.35	-1.00	-0.11
KInStarB	-0.04	0.17	-0.05	0.24	0.73	-0.06	0.04	0.07	0.05	0.07	0.19	0.10	0.11	0.29	0.09	0.22	0.29	0.06	0.10	0.15	0.24	0.25	0.05	0.24
KOutStarB	-0.06	0.09	-0.07	0.07	0.66	-0.10	-0.04	0.11	-0.10	0.32	0.10	0.09	0.13	0.37	0.01	0.20	0.24	0.07	-0.08	0.09	0.13	-0.06	0.05	0.15
KLStarB	-0.26	-0.18	-0.01	0.05	-1.15	-0.14	0.15	-0.06	0.08	-0.81	-0.08	-0.29	-0.91	-0.90	-0.60	-1.58	-0.52	-0.19	-0.51	-0.45	-0.58	-0.72	0.06	-0.37
K1StarB	-0.16	-0.09	-0.07	-0.14	-0.20	-0.18	0.25	-0.07	0.10	0.13	0.03	-0.02	-0.33	0.05	-0.41	-0.07	-0.34	-0.20	-0.31	-0.48	-0.30	-0.84	0.09	-0.42
C1LStarB	-0.36	-0.24	-0.03	0.34	-0.38	-0.15	-0.04	0.17	0.10	-0.86	0.38	0.12	-0.25	-0.08	-0.04	-0.58	0.64	0.10	0.00	0.03	-0.37	-0.37	0.22	0.72
TKTriangleB	-0.51	-0.09	0.25	-0.06	1.53	-0.16	-0.03	0.17	-0.14	0.96	0.41	0.08	0.28	0.27	0.44	0.85	0.85	-0.38	-0.33	-0.45	0.66	-0.92	-0.11	0.61
CKTriangleB	-0.56	-0.04	-0.16	0.49	0.60	-0.59	-0.20	0.97	-0.17	0.54	0.72	0.35	-0.63	0.07	0.07	1.19	0.69	-0.27	-0.23	-0.23	-0.54	-2.05	-0.08	0.22
DKTriangleB	-0.48	-0.16	0.28	0.02	1.04	-0.01	0.03	0.07	-0.01	0.17	0.27	-0.16	-0.01	0.43	-0.01	0.31	0.10	-0.63	-0.17	-0.78	0.38	-0.98	-0.36	0.46
UKTriangleB	-0.57	-0.16	0.11	-0.06	1.06	-0.20	-0.02	0.21	-0.02	0.56	0.53	0.23	0.07	0.24	0.15	0.53	0.98	-0.39	-0.28	-0.57	0.30	-0.52	-0.08	0.55
TK2PathsB	-0.14	0.07	-0.06	0.12	0.04	-0.08	0.04	0.05	-0.11	-0.03	0.04	0.03	0.00	0.00	-0.09	0.01	0.00	-0.01	-0.07	0.01	0.02	-0.73	-0.02	0.02
DK2PathsB	-0.05	0.08	-0.07	0.08	0.09	-0.11	-0.02	0.04	-0.08	0.01	0.01	0.05	0.01	0.04	-0.09	0.01	-0.01	0.02	-0.09	0.02	0.03	-0.10	-0.01	0.03
UK2PathsB	-0.08	0.08	-0.05	0.13	-0.02	-0.10	0.04	0.08	-0.10	-0.05	0.06	0.00	-0.01	0.01	-0.09	-0.02	-0.02	0.05	-0.05	0.05	-0.02	0.02	-0.01	-0.04
RbB1	0.33	0.32	0.21	-0.62	-0.38	0.32	-0.19	0.12	-0.82	0.50	-0.15	-0.80	0.94	-1.37	-0.68	-0.63	-0.07	0.15	0.43	0.34	1.23	0.31	-0.26	-0.24
RsB1	0.34	0.30	0.14	-0.83	-0.55	0.36	-0.34	0.11	-0.84	0.30	-0.13	-0.79	0.75	-1.68	-0.86	-0.89	-0.18	0.24	0.46	0.29	0.86	0.39	-0.49	-0.29
RrB1	-0.07	0.10	-0.05	0.13	0.01	-0.11	0.02	0.07	-0.05	0.00	0.02	-0.04	0.01	-0.02	-0.03	-0.06	0.02	0.00	-0.05	-0.01	-0.01	-0.03	0.00	-0.02
T2u11B1	-0.47	-0.69	0.76	-0.17	0.34	-0.53	0.18	3.45	-0.69	-1.35	-0.29	1.07	-0.98	-1.28	-0.18	-0.29	-0.72	0.89	-0.27	1.91	0.73	1.95	-0.41	0.46
T1u11B1	-0.74	-0.12	-0.01	-0.12	-0.09	0.19	0.05	0.13	0.17	-0.30	-0.26	0.19	0.04	-0.89	-0.51	-0.43	0.04	0.11	-0.28	0.77	0.14	0.12	0.08	0.32
T1au14B1	0.22	-0.12	0.08	0.07	0.91	0.42	-0.01	0.08	0.05	0.48	-0.04	-0.18	-0.17	-0.35	0.38	0.12	0.55	0.27	-0.03	0.18	0.21	0.52	0.19	-0.01
T1au13B1	-0.59	-0.62	0.08	0.26	0.10	-0.04	-0.03	-0.04	-0.33	0.24	-0.04	-0.03	0.01	-0.79	-0.03	-0.28	-0.02	0.11	0.39	1.17	0.21	-0.26	-0.09	0.40
T1au12B1	-0.13	-0.06	0.16	-0.77	0.17	0.79	-0.05	-0.06	-0.10	0.55	0.01	-0.71	0.72	-1.18	-0.77	-0.12	-0.08	0.65	0.32	0.83	1.92	0.90	-0.63	0.02
CovArcB1	-0.05	0.08	-0.11	0.10	0.00	-0.10	0.00	0.05	-0.11	-0.04	0.04	0.02	-0.03	0.01	-0.08	0.03	0.03	0.01	-0.09	0.02	0.05	-0.04	0.03	0.02

Supplements

S5.2.2 Continued.

	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
CovArcB2	-0.01	0.06	0.00	0.03	0.05	3.32	-0.03	2.72	-0.09	0.02	0.01	0.00	0.01	-0.05	-0.05	-0.02	-0.02	-0.02	-0.05	0.00	0.01	-0.08	0.02	0.00
CovArcB3	-0.06	-2.72	-1.57	0.03	-3.09	-2.06	-2.04	0.03	-0.11	-0.05	0.03	0.08	0.01	-5.45	-4.00	0.00	-0.03	-3.15	-0.13	-0.01	0.00	-0.11	-3.55	-0.04
ArcAB	-0.28	-1.92	-1.24	-0.78	-2.00	-1.68	-1.26	-0.32	-1.37	-0.03	-1.28	0.04	-0.09	0.00	-1.83	-0.02	0.00	-1.81	-2.26	-1.93	-1.56	-0.82	-2.05	-1.30
ReciprocityAB	-0.25	-1.14	-0.06	-0.01	-0.02	-0.08	-0.66	0.06	-0.05	-0.04	0.04	0.04	-0.03	0.01	-0.02	0.00	-0.02	-1.63	-0.01	0.00	0.07	-1.04	-0.06	0.02
ReciprocityAAB	1.93	-0.87	-0.66	-0.29	-0.72	-0.89	-0.56	-0.44	-0.66	1.29	-0.78	1.10	-0.47	-0.98	-0.49	-0.60	0.22	-0.88	-1.14	-0.71	-0.50	-0.14	-0.97	-0.51
ReciprocityABB	-0.21	-0.55	-0.51	-0.37	-0.64	-0.29	-0.35	0.57	-0.30	-0.55	-0.66	-0.61	-0.77	0.26	-0.87	0.15	0.21	-0.60	-0.88	-0.71	-0.41	-0.35	-0.69	-0.36
ReciprocityAABB	-0.03	-0.20	-0.14	-0.05	-0.19	-0.12	-0.11	-0.17	-0.12	-0.14	-0.21	-0.03	-0.13	-0.33	-0.32	-0.16	-0.23	-0.25	-0.27	-0.10	-0.08	-1.00	-0.42	-0.05
In2StarAB	-0.02	0.11	-0.06	0.06	0.04	-0.12	0.02	0.06	-0.03	0.03	-0.03	0.02	-0.02	0.00	-0.12	0.04	0.00	0.02	-0.05	0.00	0.00	-0.03	0.01	-0.02
Out2StarAB	-0.04	0.07	-0.03	0.10	0.03	-0.14	-0.02	0.07	-0.08	-0.02	-0.01	0.02	-0.06	0.03	-0.13	-0.03	0.04	0.03	-0.05	0.06	-0.03	-0.05	0.04	-0.05
Mixed2StarAB	-0.05	0.10	-0.05	0.11	0.01	-0.15	-0.06	0.08	-0.02	-0.02	0.02	0.01	-0.03	0.04	-0.13	0.03	0.04	0.01	-0.05	0.06	0.03	-0.02	0.02	-0.06
Mixed2StarBA	1.43	-0.05	-0.24	1.56	-0.59	0.89	-0.62	0.10	-0.23	0.97	1.13	-0.26	0.02	0.43	0.47	0.91	-0.36	0.55	0.11	0.13	0.85	-0.68	0.38	-1.27
TABA	1.06	-0.72	0.32	-0.20	1.26	-1.21	-0.68	-0.49	0.32	1.43	-1.05	-0.60	-0.32	-0.37	-0.20	-0.11	-0.22	-0.31	0.11	-0.61	-0.22	-0.73	-0.93	-0.79
TABB	0.65	0.10	0.10	0.69	1.45	0.21	-0.32	0.67	-0.28	0.33	-0.13	-0.01	0.68	1.53	0.87	0.17	-0.14	0.57	0.52	1.90	-0.20	1.32	0.85	0.52
TBBA	1.14	0.36	-0.62	0.65	1.28	3.41	0.14	0.01	0.05	1.89	0.98	0.49	3.03	1.62	1.16	1.52	1.66	2.06	0.50	2.33	2.82	1.61	1.45	-0.30
TBAB	-0.49	1.00	0.03	1.33	1.08	0.69	0.81	0.24	0.04	-0.64	0.30	0.16	1.33	1.80	0.08	0.55	0.89	-0.04	0.47	0.63	0.31	-0.43	0.73	-0.17
TAAB	0.02	0.10	-0.15	0.09	-0.07	0.06	-0.22	-0.03	0.05	0.15	-0.04	0.52	-0.06	0.20	-0.03	0.38	-0.13	0.09	-0.17	0.15	-0.08	-0.01	-0.24	0.11
TBAA	-0.03	0.18	0.35	-0.19	-0.20	0.02	-0.23	0.89	-0.16	0.65	0.32	0.84	0.45	0.32	-0.08	1.35	0.01	-0.04	-0.23	0.80	0.43	-0.14	-0.07	-0.27
CAAB	-1.22	-0.23	-0.07	0.84	0.64	0.04	-0.65	0.31	-0.04	0.47	0.88	0.30	0.18	0.48	1.07	1.57	-0.40	-0.15	0.15	-0.54	2.67	-0.86	0.87	-0.73
CBBA	-0.11	-0.09	-0.05	1.40	0.38	0.63	-0.23	0.18	0.06	0.56	0.98	-0.43	0.05	2.05	0.31	1.41	-0.93	1.07	0.33	0.42	0.15	-0.29	1.27	-0.20
IsoAB	-0.39	-0.18	-0.15	-0.27	-1.00	-0.16	-0.05	-0.03	-0.14	-1.00	1.11	-1.00	-1.00	-1.00	-1.00	-1.00	-0.15	-0.58	-1.00	-1.00	-1.00	-0.14	-1.00	-1.00
TKTABA	0.43	-0.69	0.60	0.00	1.54	-1.19	-0.74	-0.42	-0.02	1.70	-1.07	-0.31	-0.16	-0.32	-0.22	-0.71	-0.31	-0.27	0.10	-0.78	-0.06	-0.73	-0.80	-0.68
CKTABA	-1.25	-0.10	0.38	0.57	0.84	-0.19	-0.52	0.45	-0.02	0.68	1.07	0.58	0.22	0.53	0.61	1.09	-0.44	-0.12	0.05	-0.53	2.38	-0.87	1.28	-0.62
DKTABA	-0.02	0.07	-0.07	0.05	-0.01	-0.10	0.02	0.07	-0.01	0.00	0.03	-0.04	-0.07	0.02	-0.02	0.06	0.04	-0.03	-0.06	-0.01	0.02	0.01	-0.04	-0.06

S5.2.2 Continued.

	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
UKTABA	0.03	0.04	-0.05	0.06	0.01	-0.14	-0.09	0.07	-0.07	-0.04	0.09	0.05	-0.05	0.03	-0.03	-0.03	0.07	0.04	-0.03	0.01	0.01	-0.06	-0.05	-0.06
TKTBAB	0.43	-0.69	0.60	0.00	1.54	-1.19	-0.74	-0.42	-0.02	1.70	-1.07	-0.31	-0.16	-0.32	-0.22	-0.71	-0.31	-0.27	0.10	-0.78	-0.06	-0.73	-0.80	-0.68
CKTBAB	-1.25	-0.10	0.38	0.57	0.84	-0.19	-0.52	0.45	-0.02	0.68	1.07	0.58	0.22	0.53	0.61	1.09	-0.44	-0.12	0.05	-0.53	2.38	-0.87	1.28	-0.62
DKTBAB	-0.02	0.07	-0.07	0.05	-0.01	-0.10	0.02	0.07	-0.01	0.00	0.03	-0.04	-0.07	0.02	-0.02	0.06	0.04	-0.03	-0.06	-0.01	0.02	0.01	-0.04	-0.06
UKTBAB	0.03	0.04	-0.05	0.06	0.01	-0.14	-0.09	0.07	-0.07	-0.04	0.09	0.05	-0.05	0.03	-0.03	-0.03	0.07	0.04	-0.03	0.01	0.01	-0.06	-0.05	-0.06
mrs1	0.81	-1.64	-0.85	-0.54	-1.85	-1.24	-0.92	0.77	-0.71	1.68	-0.57	0.05	0.15	-1.39	-1.07	0.78	0.10	-1.66	-1.34	-1.11	-1.16	-0.67	-1.64	-0.94
mrs1	0.81	-1.64	-0.85	-0.54	-1.85	-1.24	-0.92	0.77	-0.71	1.68	-0.57	0.05	0.15	-1.39	-1.07	0.78	0.10	-1.66	-1.34	-1.11	-1.16	-0.67	-1.64	-0.94
exab1	0.44	-0.87	1.03	-0.89	0.21	-1.04	-0.94	0.15	0.11	1.33	-0.26	-0.32	1.57	1.90	-0.30	0.09	-0.23	-1.52	-0.53	-1.10	1.15	-0.39	-0.49	-0.78
exba1	1.27	-1.21	3.96	-1.60	-0.42	-0.69	0.25	1.31	1.75	-0.15	0.78	-0.93	0.91	1.52	-1.91	-0.83	1.98	-0.77	3.00	-1.31	1.96	-0.19	0.10	-0.71
mrb1	1.19	-1.51	-0.63	-0.46	-1.79	-1.05	-0.83	0.91	-0.55	2.24	-0.56	-1.08	0.20	-0.81	-0.90	0.83	-0.41	-1.65	-1.24	-0.96	-0.72	-0.61	-1.68	-0.89
mrbm1	0.88	-1.02	-0.62	-0.81	0.24	-0.95	-0.93	-0.84	-0.55	1.46	-1.02	-0.26	1.60	-0.97	-0.01	0.12	-0.16	-1.50	-0.81	-0.99	1.03	-0.26	-1.47	-0.72
CovArcAB1	0.32	-1.87	-1.06	-0.66	-1.93	-1.52	-1.19	0.15	-1.23	-0.34	-1.25	-0.99	-0.04	0.39	-1.63	0.13	-0.45	-1.77	-2.20	-1.75	-1.18	-0.71	-1.96	-1.24
CovArcAB2	-0.32	-0.65	-0.24	-0.39	-1.12	-0.14	-0.59	-0.48	-0.65	-0.61	-0.74	-0.92	-0.18	-1.04	-0.55	-0.94	-0.64	-0.73	-1.02	-0.44	-0.59	-0.40	-0.84	-0.42
CovArcAB3	-0.64	-1.60	-1.12	-0.47	-1.61	-1.61	-1.16	-0.50	-1.05	1.17	-0.20	1.92	0.24	-2.39	-2.00	-0.47	-0.83	-1.76	-1.15	-0.75	-1.01	-0.49	-2.29	-0.41

Notes. Gray cells indicate that fit was poor. Yellow cells indicate that fit was poor, but an accompanying statistic was not there (or they were too few). This suggest that the model expected more observations by chance than there actually were. Orange cells indicate that the observed statistic was equal to the total number of ties in the network, and could therefore not be included. This happened sometimes for CovArcA1, referring to same-sex.

S5.3 Overview of individual and classroom information for descriptive statistics summarized in Table 5.3. Classroom 1 thru 24.

Classroom	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Total size	31	22	32	31	22	30	25	24	22	26	24	23	23	29	36	36	26	20	26	22	23	23	24	27
Age (in yrs)	11.3	11.2	11.3	11.3	11.2	11.1	11.6	11.5	11.1	11.4	11.4	11.4	11.1	11.3	11.2	11.3	11.2	11.4	11.4	11.1	11.1	11.2	11.3	11.2
Boys	.32	.50	.53	.45	.55	.50	.52	.46	.45	.62	.50	.48	.35	.59	.53	.56	.42	.60	.62	.59	.57	.61	.50	.52
Respondents[a]																								
Missing	1	0	0	0	2	2	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Non-victimized	11	8	15	7	9	14	5	5	5	9	7	9	10	5	9	6	4	3	6	7	8	9	8	10
Defending involvement[b]																								
Sinks	.42	.23	.63	.35	.64	.60	.32	.29	.23	.35	.50	.39	.48	.24	.31	.25	.23	.25	.35	.45	.39	.35	.33	.33
Sources	.13	.14	.03	.10	.05	.10	.04	.04	.00	.04	.00	.13	.00	.00	.06	.00	.12	.05	.00	.00	.04	.09	.00	.07
Isolates	.06	.27	.00	.03	.05	.07	.00	.00	.05	.04	.00	.09	.00	.10	.03	.00	.04	.05	.04	.00	.04	.09	.00	.19
Actives	.39	.36	.34	.52	.27	.23	.64	.67	.73	.58	.50	.39	.52	.66	.61	.75	.62	.65	.62	.55	.52	.48	.67	.41
Average Degree[c]																								
Liking	8.2	11.1	12.0	14.7	10.4	11.7	13.1	8.2	10.5	8.2	14.7	7.0	11.3	13.5	13.1	11.5	14.5	7.8	10.0	7.8	14.1	13.0	13.9	7.9
Disliking	4.5	1.7	5.2	2.8	1.5	2.9	2.4	3.4	2.0	2.0	1.3	4.8	3.0	5.2	4.3	6.4	3.8	3.3	4.1	1.2	2.1	1.4	2.1	3.4
Defending	1.8	1.9	2.3	2.3	1.8	1.7	3.8	3.3	2.6	1.8	2.8	1.7	2.8	2.6	2.4	3.5	1.9	3.6	3.3	3.0	3.0	1.8	4.0	1.3
Same Gender[d]																								
Liking	.86	.58	.85	.58	.61	.74	.58	.76	.64	.72	.57	.81	.68	.66	.70	.76	.62	.62	.67	.57	.62	.60	.56	.83
Disliking	.36	.50	.25	.38	.47	.31	.51	.22	.47	.46	.23	.33	.40	.41	.30	.40	.31	.47	.40	.85	.42	.53	.45	.32
Defending	.98	.67	.75	.89	1	.98	.77	.85	.93	.62	.67	.95	.80	.82	.88	.92	.98	.89	.78	.80	.86	.93	.61	1
Dependency[e]																								
Def out-tie → lik out-tie	.85	.98	.77	.89	.88	.96	.84	.76	.96	.79	1.00	.74	.81	.95	.99	.89	.94	.65	.86	.53	.99	.88	.89	.88
Def out-tie → lik in-tie	.65	.90	.58	.70	.55	.73	.79	.59	.86	.66	.80	.68	.70	.88	.78	.82	.90	.55	.64	.55	.94	.85	.71	.65
Def out-tie → dis out-tie	.04	.00	.19	.01	.08	.00	.00	.03	.04	.04	.00	.00	.03	.00	.00	.00	.00	.04	.03	.02	.00	.02	.01	.03
Def out-tie → dis in-tie	.02	.02	.18	.04	.13	.04	.03	.06	.04	.06	.03	.03	.06	.00	.03	.02	.00	.06	.05	.03	.00	.00	.12	.03

S5.3 Continued. Classroom 25 thru 48.

Classroom	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
Total size	30	26	24	27	27	28	25	27	24	30	27	25	31	23	28	29	28	26	26	25	27	26	25	31
Age (in yrs)	11.3	11.3	11.4	11.3	11.3	11.1	11.1	11.3	11.1	11.0	11.5	11.4	11.3	11.3	11.2	11.1	11.1	11.2	11.0	11.3	11.2	11.4	11.3	11.2
Boys	.57	.50	.46	.56	.52	.50	.40	.37	.42	.33	.44	.52	.42	.57	.43	.48	.71	.77	.54	.40	.44	.62	.48	.58
Respondents[a]																								
Missing	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0	1
Non-victimized	9	7	5	11	4	10	7	18	11	7	14	3	8	3	4	9	6	7	5	6	9	12	8	12
Defending involvement[b]																								
Sinks	.37	.35	.38	.41	.26	.39	.32	.70	.33	.37	.33	.28	.32	.26	.14	.28	.25	.35	.23	.28	.41	.42	.32	.35
Sources	.07	.08	.13	.00	.11	.11	.00	.04	.00	.00	.07	.04	.10	.00	.04	.10	.07	.12	.00	.00	.07	.31	.04	.06
Isolates	.00	.00	.04	.00	.04	.04	.04	.00	.17	.07	.30	.00	.00	.00	.00	.03	.00	.12	.00	.04	.00	.12	.04	.06
Actives	.57	.58	.46	.59	.59	.46	.64	.26	.50	.57	.30	.68	.58	.74	.82	.59	.68	.42	.77	.68	.52	.15	.60	.52
Average Degree[c]																								
Liking	10.5	8.1	10.2	10.7	6.4	13.6	12.7	13.4	14.5	12.7	12.0	10.6	11.6	9.0	8.0	11.9	11.9	7.7	15.8	6.9	10.1	13.5	9.7	11.7
Disliking	1.3	2.3	1.5	1.8	3.3	1.8	1.0	1.7	1.8	4.9	2.7	3.7	4.5	4.2	4.3	4.8	3.5	2.5	2.4	4.7	3.7	3.4	3.8	3.9
Defending	2.3	2.3	2.8	2.6	2.4	2.6	3.3	2.7	2.5	3.0	1.2	4.3	2.6	5.5	3.6	4.1	2.6	1.5	4.8	3.0	3.2	1.6	1.8	2.7
Same Gender[d]																								
Liking	.73	.78	.72	.74	.81	.60	.71	.64	.60	.83	.65	.67	.69	.65	.78	.61	.67	.82	.57	.86	.70	.59	.63	.73
Disliking	.39	.35	.24	.41	.40	.53	.38	.27	.39	.26	.42	.42	.29	.32	.28	.49	.70	.54	.48	.40	.29	.35	.41	.45
Defending	1	.87	.84	.86	.95	.77	.96	.59	.78	.98	.97	.90	.99	.69	.95	.65	.84	.97	.77	.92	.81	.83	.72	.97
Dependency[e]																								
Def out-tie → lik out-tie	.84	.67	.82	.96	.79	.91	.96	.77	.95	.90	.70	.93	.85	.73	.81	.85	.89	.97	.81	.80	.90	.92	.92	.90
Def out-tie → lik in-tie	.75	.70	.71	.76	.70	.80	.81	.53	.80	.82	.64	.65	.68	.62	.64	.59	.80	.66	.78	.70	.67	.79	.83	.75
Def out-tie → dis out-tie	.01	.00	.00	.00	.00	.00	.00	.01	.00	.04	.00	.03	.04	.06	.01	.03	.04	.00	.00	.00	.00	.00	.02	.00
Def out-tie → dis in-tie	.01	.00	.04	.03	.03	.04	.01	.18	.07	.04	.15	.08	.04	.11	.06	.11	.15	.00	.05	.08	.05	.04	.08	.04

Notes. [a]Mssing are those who belonged to the classroom and who did not fill out the questionnaire. Non-victimized students indicated not being victimized by classmates on the general and more specific Olweus questions regarding bullying (Olweus, 1996); [b]Sinks are actors with zero out-ties and at least one in-tie, sources are actors with at least one out-tie and zero in-ties, isolates are actors with zero in-ties and zero out-ties, and actives are children with at least one out-tie and at least one in-tie; [c]Average nomination per respondent for liking, disliking or defending in classroom; [d]Proportion of ties that were of the same gender; [e]Proportion of out-ties for defending that are also out-/in-ties for (dis)liking.

Supplements

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About the author

Ashwin Rambaran was born in Paramaribo, Suriname on July 28, 1983. He moved to Assen, the Netherlands when he was three years. In 2009 he obtained his bachelor's degree in engineering at the Hanze University of Applied Sciences in Groningen, the Netherlands. At the end of his bachelor's degree, he completed a minor in Sociology at the University of Groningen. In 2011 he successfully completed the academic master of Sociology with a research specialization in Criminology. His master thesis resulted in a first-authored scientific article in an international peer reviewed journal. In September 2013, he started a PhD at the Interuniversity Center for Social Science Theory and Methodology (ICS), at the Sociology Department of the University of Groningen. During his PhD he was involved in a large-scale data collection among elementary school students (KiVa). Ashwin is currently employed as a postdoctoral researcher at the Department of Developmental and Social Psychology at the University of Padova, Italy, where he studies the social networks of young Italian adolescents paying special attention to understand adolescents' bystander behavior in bullying through the interplay of individual and contextual morality.

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